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THE PERSISTENCE (SURVIVAL) OF MICROORGANISMS

FINAL REPORT OF LITERATURE SURVEY

carried out by

THE UNIVERSITY OF TEXAS - MEDICAL BRANCH

for

P D DIVISION

THE BIOLOGICAL LABORATORIES, CHEMICAL CORPS, CAMP DETRICK

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INTRODUCTION

The work on this project was carried out over the period of 1 April, 1951 to 28 February, 1953.

Considerable interest has evidenced itself since the study of microbiology was begun to determine the survival or death of organisms under the influence of nature, as well as physical factors under laboratory conditions. The reports of these studies are scattered throughout the biological literature. They have never been collected in a survey in an effort to bring all of the available data together for correlation of the material.

A survey of the literature has been made on the survival and persistence of microorganisms under varying conditions as follows:

Methods and Materials

1. Information on the stability, persistence or survival of microorganisms under natural or experimental conditions may be found in bacteriology textbooks, scientific biological journals, abstracting journals and in indices such as the Quarterly Cumulative Index Medicus.

2. A systematic survey of these sources gave as full a coverage of the literature as possible for this project.

3. The primary sources for material in this project were:
   (a) Bacteriology texts by: Topley and Wilson, Zinsser, Dubos, Rivers, and other texts.
   (b) Biological Abstracts
   (c) Chemical Abstracts
   (d) Quarterly Cumulative Index Medicus

   Original articles were then obtained from the original journals.

4. The range of information collected appears in a selected outline below:

(a) Source

1. Air
   - bacteria
   - fungi
   - microorganisms
   - rickettsia
   - viruses,
     - survival of
     - persistence of
     - recovery of

2. Body (as under air)

3. Culture Media (as under air)

4. Food (as under air)

5. Insects (as under air)

6. Pressure (as under air)

7. Radiation (as under air)

8. Soil (as under air)

9. Surfaces (as under air)

10. Water (as under air)

(b) Organisms (general)

1. Bacteria
   - persistence of
   - survival of
   - recovery of
     - in water or ice
     - in air
     - on or in insects
     - in soil
     - in milk
     - in food
     - in feces
     - on surfaces (wood,glass,concrete,etc.)
     - under natural conditions

2. Microorganisms (as under bacteria)

3. Rickettsia (as under bacteria)

4. Viruses (as under bacteria)

5. Yeasts, molds and fungi (as under bacteria)

(c) Particular (organisms) diseases

1. Anthrax-Bacillus anthracis
2. Brucellosis - Brucella abortus, melitensis, suis
3. Cholera - Vibrio comma
4. Coccidiomycosis - Coccidiodes immitis
5. Dysentery - Shigella spp.
6. Encephalitides - viruses
7. Influenza - virus
8. Plague - Pasteurella pestis
9. Poliomyelitis - virus
10. Psittacosis - virus (and other viral diseases)
11. Tularemia - Pasteurella tularensis
12. Tuberculosis - Mycobacterium tuberculosis
13. Typhoid - Salmonella typhosa
14. Typhus - Rickettsia (and other rickettsial diseases)
15. And others

5. The material in the textbooks was covered chapter by chapter on each genus or species of organism and original references to the literature as well as general statements in the text were recorded on a special form. Information relating to each species was recorded on individual sheets. Specific references from the body of the text and bibliography of the chapter were recorded with specific data on a special form on a 5" x 8" file card.

6. The Abstracting Journals were searched as follows. For each Biological and Chemical Abstracts, a complete list of the index titles which might yield information pertaining to the project was prepared and was used as a guide for searching through each yearly index. References of apparent value were taken on a form listing

subject and abstract numbers. After completing a yearly index, the abstracts were checked from the numbers recorded to determine if they had information on survival and persistence. If not, the reference was discarded. If questionable, the title was taken to check the original article. If pertinent, specific data was recorded on the face of the file cards and general methods were recorded on the back of the card.

The original article was obtained wherever possible and read for further data and to check the data in the abstract for accuracy. General information on methods was recorded on the back of the card. References in these articles to original work were recorded on separate file cards and the original articles obtained and read for appropriate data and information.

7. The Quarterly Cumulative Index Medicus titles were surveyed and a list of titles which might yield information pertaining to the project was prepared. Since only titles of articles, and not abstracts, appeared in this publication, the appropriate titles were taken directly to the file cards. The original articles were checked as were the articles found in the abstracting journals, read, and data recorded.

8. The Library of the University of Texas Medical Branch has an extensive number of domestic and foreign scientific journals. However, since some original articles appeared in journals not available in our library, reprints were requested whenever possible from the authors, or requested from the microfilm service of the Army Medical Library in Washington, D. C.

9. The cards were filed according to subjects; Air, Body, Culture, Food, Insects, Pressure, Radiation, Soil, Surfaces and Water with cross reference cards in each section where an article had information

on persistence of organisms in or on more than one of the topics listed. From the cards, the data were transferred to forms, collecting all of the particular information on one group of organisms together. This information was then tabulated on multilith stencils and a survey of the data prepared for each section.

Note here! Because of the tremendous amount of data, it has been impossible to collect it in a form to suit all who may need turn to it for reference. It is recommended for those who have a particular interest in one factor affecting the survival of organisms or the factors affecting the survival of one organism that they use these tables as a guide and refer to original work in the references for more complete information.

It is certain that with a large report of this type that one might, by close reading, be rewarded some misspelled words, some occasional organisms slightly misplaced and some of the references listed by wrong volume or page. It should be noted also that the literature covered in the report is from 1885-1953. During that time the names of organisms have changed several times with the result that old or outdated names may appear in certain places in the report.

ACKNOWLEDGMENT

This report was made possible, to a great extent, through funds made available on contract DA-18-064-CML-463 from P. D. Division, Biological Laboratories, Chemical Corps, Damp Detrick, Frederick, Maryland, and through the interest of Drs. Charles Phillips and Saul Kaye.

The literature survey was carried out in the Department of Bacteriology and Parasitology of the University of Texas Medical Branch, Galveston, Texas, where the facilities of the Medical Library were utilized to a great extent. Some foreign and obscure journals were obtained by microfilm through the Army Medical Library, Washington, D. C.

Most of the work was done on a part-time basis by personnel of the University of Texas, who were responsible for the searching, reading, tabulating and writing-up of the material. These workers were:

Wilbur White	Martha Jordan
William Dillen	Norman Halbrooks
Jacqueline Terrill	Mary Faubion
Meredith Holladay	Elise R. Stein
Pat Riddle	Jean Cobb
Beatrice D. Engley	Louis DeVito
Elfe Thomas	Maxine Munn

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Responsible Investigator

THE SURVIVAL OF ORGANISMS IN AEROSOLS

One of the important methods of transmission of disease producing organisms is through the air--air borne infections. An aerosol is a suspension of particles in air, in this particular instance a suspension of microorganisms in air. In nature, organisms may get into the air from the wind blowing over water and soil, raising microscopic water particles and dust particles into the air and suspending them there. Potential pathogens get into the air of human environment from sneezing, coughing and expectorating as well as from clothes, bedding, sweeping of floors and other similar sources. Under such conditions these factors affect spread of infection (1) the organism virulence; (2) the host susceptibility; (3) effect of environment on organism preventing or aiding it in survival.

Aerosols of microorganisms may be set up experimentally by man in open or closed areas to study various factors affecting survival. These factors may be divided for convenience as to (1) environmental factors and (2) organism factors.

These aerosols may be of organisms not usually considered as air borne infection organisms as we usually consider them in nature.

Environmental Factors Affecting:

There are many major and minor factors which may affect the ability of an organism to survive in an aerosol. The medium in which the organism is grown and the medium from which it is suspended for spraying may aid or adversely affect the organism. The growth medium may supply nutrients for production of active, well-developed cells. The suspending medium provides osmotic effect as well as protection against drying too rapidly or slowly, protection against radiation and other forces.

The temperature of the air may affect the survival of an organism in an aerosol to a certain extent. Usually at higher temperature lower recoveries may be expected if the relative humidity (RH) is constant.

The RH of the air is very important in the survival of organisms. Various organisms may respond differently to high and low RH but usually at a 50% RH greater destruction of the organisms result. At high or low humidities better recovery may occur. As noted, individual organism types may respond differently to different humidity levels. Some organisms are killed if they dry too rapidly so low RH levels are detrimental. Others appear to give lower recoveries if sprayed into very high humidity air. From theoretical grounds this might be explained on the basis that particles sprayed into saturated air may act as nuclei of rain drops and precipitate out or may merely hit one another and form large particles which stick together and then precipitate out of suspension.

The amount of radiation present affects the rate of organism survival in an aerosol. Organisms are destroyed in sunlight and artificial sources of ultra violet more readily than if present in an aerosol in semi-darkness or in absence of all light or artificial radiation. The sunlight accounts for a great amount of destruction of air organisms along with desiccation.

The method by which organisms are rendered air-borne is important in their survival as aerosols. In nature, organisms covered with a film of moisture or soil or oily film of dust will be protected against desiccation and radiation. In experimental aerosol production, the type of spray device is of importance. The rate of spray, amount of shearing force put on the cell and the size of particle developing will affect survival in the air. Some sprayers

may destroy the cells by the force of spray; others form large particles which do not stay air borne for long periods. For infecting animals, particles smaller than 10 micra in diameter must be formed and viable organisms must be present.

In nature the amount of air movement is important in keeping the organisms suspended. Also important is the resuspension of organisms as secondary aerosols by air and wind movement as well as by human and vehicle traffic.

The method of sampling aerosols is important in evaluating the results. If present as large particles (over 10 micra in diameter) then they will settle out rapidly and may be sampled on "drop-plates". Various types of samplers may collect particles within a certain range--some particles may be too big and others too small. This must be taken into consideration. As mentioned previously, particles above 10 micra in diameter are too large to be respired by animals so that aerosols of particles may be quite viable but too large to cause respiratory infection.

<u>Organism Factors Affecting:</u>

Each genus and species of organism may have its own characteristics which may protect it from destruction when present as an airborne organism. The individual strain of organism sometimes has certain characteristics which allow it to remain viable more or less long than closely related strains and species. Some organisms may be protected by their presence as a spore or by their capsule or resistant cell wall. All of these characteristics resist the forces of nature--desiccation, radiation and temperature changes as well. The size and shape of the organism and rigidity of the cell wall aid an organism to resist the forces present in spraying procedures.

The age of the cells (in the growth curve) at the time of spraying determines to a certain extent their resistance to desiccation, radiation and other factors. The length of storage before spraying may be another factor. The numbers of organisms in the spray medium and the total numbers of organisms will also affect the length of survival of the aerosol.

SUMMARY

*Bacillus (Table A 1) B. anthracis spores resisted ozone for 4 hours and could withstand direct sunlight for days. B. subtilis resisted UV and remained viable in air for 5-7 days, experimentally. B. anthracis apparently survived 200 F. for 24 hours. B. megatherium was transported for many miles by storms.

*Brucella (Table A 2) Brucella melitensis survived in dust for 30-44 days experimentally. In nature it survived equally long. High rainfall areas have Brucellosis - arid areas none. Sunlight quite effective in killing organisms.

*Clostridium (Table A 3) Vegetative cells susceptible to oxygen.

*Corynebacterium (Table A 3) The diphtheria organism survived in dust for 7-102 days or longer. Organisms found in air from diphtheria patients. It survived 48 hours in air.

*Lactobacillus (Table A 3) The organisms (L. acidophilus) settle out of air rapidly (5-10 minutes). Radiation is not too effective against it.

*Neisseria (Table A 3) The N. meningitidis organism can travel and infect in wards up to 5 feet in distance.

*Vibrio comma (Cholera) (Table A 3) During the cold months the organism dries and dies. Experimentally dried in air it may survive up to 108 hours.

*Diplococcus pneumoniae (Table A 4) Survives only 42 minutes in sunlight but 42 hours in dark. RH of 50% is very lethal but not with NaCl removed. The lethal effect is raised with larger particles and higher temperatures. Organisms in floor dust for over one month. Usual survival in air is short but many survive for 48 hours.

*Escherichia coli (Table A 5) Recoveries up to 25% many be obtained in air. Faintly resistant to ultra-violet especially with increased humidity. Cigarette smoke protects from chemicals in air. It may survive up to 4 years in dust.

*Microorganisms (Table A 6) General factors affecting survival of organisms at altitudes are presented. Some organisms found up at 70 thousand feet. In experimental studies factors affecting survival of organisms in general are presented (temperature, radiation, chemicals, air conditioning). Scattered reports are listed for Erwinia, Hemophilus, Malleomyces, Micrococcus, Proteus, Pseudomonas and Sarcina. Several reports are present for Serratia as follows: The organism survives as long as one day in air. One report indicates using nose as sampler. Nose and throat fluids are toxic to Serratia. Low humidity destroys organism rapidly. Reports on Proteus suggest survival of 2-12 days.

*Mycobacterium tuberculosis (Table A 7) Organism survives 8-14 days in dust and 4-7 days in sputum droplets but 2 months in sputum. Ultra-violet and glycols tested against organism.

*Pasteurella (Table A 8) The plague organism dies rapidly on drying but is infective by air route. The tularemia organism is inhaled from grain dust to infect..

*Protozoa (Table A 9) E. hystolytica cysts did not survive when air dried.

*Phage (Table A 9) Survives air drying and can be disseminated through air.

*Rickettsia (Table A 9) Typhus may be transmitted through air. C. burneti is reported in goat barn. Rickettsiae grown in egg and sprayed survive 30 minutes in air.

*Salmonella (Table A 10) Sprayed into air, the organisms survive 8-24 hours. Higher Rh and temperature lower recovery. Dust protects the cells and organism survives sun rays for 4-10 hours.

*Staphylococcus (Table A 11) RH of 50% is lethal. Survives 3 days in air. Ozone not very toxic. Survives in floor dust for several days. May be quite resistant to UV light.

*Streptococcus (Table A 12) Killed by sunlight in 4 hours but lives in dark for at least 65 hours and perhaps up to 2 weeks. Good survival in high and how humidity, but not 50% RH. Infective as small particles (2 micra). Particles near 12 micra diameter not as infective. Survives in air for 48 hours. Sunlight and UV are detrimental. Organisms from air may survive in blankets for 4 months. There may be 40 per 10 cubic feet of air in hospital wards or up to 378 per cubic foot. Glycols may reduce population 90%.

*Viruses (Table A 13) May be found at high altitudes.

Influenza - Survives in dust less then 3 weeks. 50% RH more effective in destroying virus then higher RH. Some disagreement, however, exists over RH effect. Virus from air on blankets survives drying. It may survive many days in air but glycols and sunlight destroy it rapidly.

Vaccinia - Survives in air 8 hours, being more susceptible to destruction than Streptococci. Resists radiation like bacteria.

Foot and Mouth - Survives 1 week in outdoor air and in dust.

Smallpox - Seasonal incidence indicates low humidity favors the disease.

Infectious Jaundice - Virus carried in air by being dust-borne.

*Yeasts, Molds and Fungi (Table A 14) Some of these species are found at 10 thousand to 36 thousand feet high. Some may travel 100 miles or 300-400 miles or even as far as 1200 miles to infect plants. Some species isolated in [illegible]. Resistance to UV is high. Certain human diseases are affected by low RH and wind to dry and carry spores (coccidiomycosis) while others need high RH and lower temperatures such as Sporotrichosis.

SURVIVAL OF ORGANISMS IN THE BODY AND BODY MATERIALS

The importance of the persistence of microorganisms in the body materials during life and after death has been recognized as a major problem and hazard for a long time. The disposal of body excreta, tissues and carcasses themselves have been influenced by the realization that potentially pathogenic organisms might survive in them for long periods depending on certain factors of nature.

The handling of blood, tissues, and other specimens in laboratories and hospitals require precautionary measures since some pathogens may remain alive for a short time and others survive for long periods. The length of survival affects culture procedures for isolation of the organisms since the organism may die off readily. On the other hand, some organisms are kept in blood or tissue in the laboratory because the organisms survive in them for a very long time.

A distinct hazard and problem is the persistence of pathogens in secretions and excretions such as sputum, urine or feces. The proper disposal methods depend on organism survivals and persistence in these materials.

Of interest also is the survival of animal, plant and human pathogens in meats and meat products or on plants or plant products which are to be handled or eaten by susceptible individuals or which are to be disposed of without danger to other susceptibles.

The factors involved in the survival and persistence of microorganisms in the body and body materials may be divided into (1) body or body material factors; (2) factors in nature and (3) organism factors.

<u>Body or Body Material Factors Affecting:</u>

Microorganisms may survive in body tissues, fluids or carcasses

for varying lengths of time. The body materials may on one hand provide food and protection from outside influences or on the other, may through pH of stomach or intestine, antagonistic organisms in the intestinal tract or antibodies or other antibacterial factors destroy the pathogens. Some organisms will survive for long periods in whole blood or serum at low temperature. Other organisms will be in tissues and be viable for long periods. Some organisms expelled in urine and feces are not destroyed readily by pH and antagonistic organisms but will be protected and survive. In sputum some organisms are destroyed but may survive well when suspended or dried outside the body. Body fluids through protective colloids are able to allow organisms to withstand forces of nature.

Forces of Nature or Environment Affecting:

Most organisms will persist for longer periods at lower temperatures. At temperatures high enough to allow metabolism to take place, the organisms will grow but kill themselves sooner with detrimental end-products such as acids, aldehydes and other substances. The amount of radiation will affect organism survival, depending on the amount of protection the cells have by organic matter. Wind and rain can wash away and dilute the organisms. Freezing and thawing also may affect the survival of members of cells as well as the heat of the sun if the organisms are near the surface. Another factor affecting survival of organisms in body materials in nature would be the RH if exposed to air. The interplay of temperature and RH is important. If not at soil surface, then the depth at which the body or body material is buried will affect survival.

Organism Factors Affecting:

The general and specific characteristics which are a part of a

particular cell will affect its ability to survive in the body and body materials. The virulence of the cell and its ability to invade certain tissues are important in determining its presence and survival there. Its resistance to light and other radiation, heat and cold, freezing and thawing, desiccation and temperature, and humidity changes will determine its survival and persistence. Ability to grow at low temperatures or survive at low temperatures, the presence of protective capsules or a spore stage or a particularly resistant cell wall and protoplasm all are important.

SUMMARY

*Bacillus anthracis (Table B 1) Survival data suggest 60-90 days in blood either moist or dry; in guinea pig blood at 25-30 C. for 1-9 months or at 5-10 C. up to 159 days; the organism may be found in feces and urine of cases. Skin apparently inhibits the organism. In body tissue, survival is given for several days up to 9 months, depending upon condition.

*Spirochetes (Table B 2)

Borrelia - Survival is listed at refrigeration temperature for 100 days in blood, at -48 C for 27 months; in feces for 4 weeks and tissues for 1 year.

Leptospira - Survival in blood for 7 days in dark, in feces for 24 hours but in urine for weeks or months. At refrigerator temperature in tissues survival of 26 days is given but at -20 C. 100 days survival is listed.

Treponema - In blood survival is only for a few hours at body or room temperature but in refrigerator for several days and at -20 to -78 C. survival of months to 3 years is given. In tissues at 5 C. for several days in bodies. Some tissues may stay with viable organisms for 7-10 days or longer. At frozen conditions -10 C to -78 C survival of 2 months to 3 years is given.

Spirillum - Survives 1-5 years frozen and in rabbit blood.

*Brucella (Table B 3) In blood the organisms may live for 3-6 months or up to 5-9 years depending on reports. In feces, data suggest 100 days in dark or 20 days in manured soil. In a patient the organisms were found in feces during 16th month of disease. Skin apparently inhibits the organisms. In urine survival of 6-30 days is listed. In tissues persistence may be for a month to 7-9 months.

*Microorganisms (Table B 4)

Clostridium - C. tetani found in tissues for 4-6 months and feces for 16 days. Gas gangrene organisms found in wound areas for five years. Botulism organisms found in intestines for 4 months.

Corynebacterium - Diphtheria organisms in blood for 13 years in laboratory. In tissues for 9 weeks to 4 months and in throats for 6 months in virulent form.

Erysipelothrix - Alive in tissues for a month, in sunlight for 10-12 days and in buried carcass for months.

Hemophilus - H. influenzae survival in blood for a short period but H. pertussis lived for weeks.

Lactobacillus - Alive for over 5 years in blood.

Malleomyces - From blood and urine remained alive 16-27 days.

Microbacterium - Found alive in blood for 5 years.

Proteus - In blood survivals of 3-9 years are reported. On skin survival was better than on filter paper.

Pseudomonas - Five year survival in blood is noted and resistance to drying on skin better than on filter paper.

Serratia - Organisms remained alive for 5 years in blood. Survivals on skin were better than on filter paper. Drying appeared to be important in destruction on skin.

*Diplococcus pneumoniae (Table B 5) Studies in blood suggest survival of a few months when dried on surfaces and of 5-9 years in tubes. In sputum, persistence of 4 months is reported; when dried on surfaces, a few hours in sunlight to 30-40 days in dark is reported.

*Escherichia coli (and coliforms) (Table B 6) Survival in feces in dark or light, fluid or dried varies with report from 3 days in sun to over a year or two. On skin organisms alive for a few minutes to hours. In urine the organisms may live over 100 days. Aerobacter aerogenes in feces 9-16 days, inhibited by normal skin and alive in blood 3-9 years.

*Metazoa and Protozoa (Table B 7)

Bartonella - In blood for less than 3 days. Heating and chilling destroy it rapidly.

Entamoeba - Transient viability in feces stored at high temperatures (a few hours) but up to 14-17 days at low temperature. On skin cysts survive only a few minutes.

Necator - In feces plus urine for 2-3 weeks, in feces in lab for 13 months and for 3-7 months in soil. In sunlight destruction was in 1-2 hours for larvae.

Ascaris - In sunlight for a few hours but in fecal soil for days to a few weeks.

Trichuris - In fecal material survival of 14 days to 3 months. Increased temperature destroyed the organism readily.

Trichomonas - In pus for 3 hours and vaginal discharge for over 5 days. In laboratory with gastric mucin survival of 2-4 years.

Trypanosomes - Do not develop in blood of bats at low temperature.

Trichinella - Survives a few hours at sub-freezing temperatures.

Plasmodium - In blood at -50 to -70 C. for 10-15 days.

*Molds, Yeasts and Fungi (Table B 8)

M. audouini - In hair survives for 125-420 days.

Tricophyton - Remains viable in toe scrapings for 300 days.

Coccidioides - In sputum in soil for 30 days as vegetative form and 240 days as parasitic form.

*Mycobacterium tuberculosis (Table B 9) In blood survival of 14 days while controls in saline live 10 weeks. In fecal material persistence of a few days to several months in nature and 2 years artificially in fecal material. In pus for 3-4 months and skin for 7 years. Sputum samples vary in viability from 1-7 days to over 180 days depending on temperature, light and humidity. In urine it lived for several months.

In tissues death resulted rapidly in light and when dried but at low temperatures and if buried survival of 90-167 days reported or even 1-3 years in lung tissue.

*Micrococcus Species (Table B 10) (Staphylococcus) In blood for 9-19 years. In feces the effect of sunlight is negligible. On skin drying seems to be the antibacterial factor; low pH affects some while the presence of dirt or fat seems to protect organisms. In pus organisms survive at room temperatures for 2.5-3.5 years with no loss in pathogenicity. The organisms resist pH changes considerably. Gaffkya may live in blood for 5 years, Sarcina are killed rapidly in throat.

*Neisseria (Table B 11) The gonococcus stays alive in serum for 7-8 weeks to 16 months. In uretheal discharges the organism lives for a few hours at room temperatures. Reduced temperature gives longer survival. In body it may live almost 3 years. The meningococcus may live in nasopharynx for an average of 6 months. In dried secretions viability of several days is reported. In blood the Neisseria live 6 weeks to 3 months.

*Pasteurella (Table B 12) The plague organism remained viable for 100 days in blood, 3 months in urine, in tissues reports of several weeks in carcasses to 1-2 years in refrigerator to 7 years glycerinated at -15 C. Frozen tissues give 6-42 month survival of P. tularensis and up to 10-13 years in glycerinated tissues at -14 C. Pasteurella may live in feces for a few days in nature to several weeks experimentally.

*Rickettsia (Table B 13) Certain of the rickettsia exist for only 12 days in blood refrigerated, others for 95 days at -70 C. and others for 610 days. In feces survival of 6 years is reported. In tissues at freezing temperatures viability of nearly a year is suggested, for almost 2 years with another while at 5 C. 2-3 months survival is recorded.

*Salmonella Species (Table B 14) In blood under lab conditions survival of 7 years is reported. In feces, 8 days to over 8 months is listed. On skin survival of 10-20 minutes on clean skin to several hours on dirty or fatty skin is suggested. Frozen turkey skin harbors the organism for over a year. In tissues the organisms withstand heat for short periods.

*Salmonella typhosa (Table B 14) In blood for at least 7 years, one strain for 18 years, others up to 10 years in virulent state. In feces for a few days to 5 months with varying conditions. The normal skin does not allow survival but for a short time. In urine for 2-3 days at high room temperatures to 14 weeks. In tissues existence for 140-160 days is suggested.

*Shigella (Table B 15) In feces under varying conditions survival of a few hours on fruit to over 200 hours in desert to several days and even up to 113 days in dried feces. In urine at room temperatures up to 40-50 days. Gastric juice was germicidal.

*Streptococcus (Table B 16) In blood survival of a few weeks (4-8) to 7-19 years is recorded. On skin streptococci survive for 1-2 hours. In sputum viability may be as long as 150 days. In tissues 3 month to 6 month survival is recorded.

*Vibrio (Table B 17) In blood the organism exists for 47 hours to 8 days and longer (5 weeks) in blood broth. In feces under adverse conditions of pH and sun and temperature viability varies from 24 hours to 30 days. In urine extremes of 6-40 days are recorded.

*Viruses (Table B 18)

Hoof and Mouth - In blood and serum at low temperatures for several weeks to months for survival and in lymph existence for over 2 years is listed. In feces survival of 2 months to almost a year is suggested at low temperature. In tissues viability of the virus remained for 2-5 months at refrigerator temperatures.

Herpes - Alive only 40 minutes in normal rabbit serum, 10 minutes in serum plus UV. In brain suspension it lived for 100 hours.

Yellow fever - In blood it was viable for 154 days when frozen but in blood and liver at -10 C., 2 weeks.

Rift Valley - Long viability in refrigerator at 82 days or 2 years. In serum survival at refrigerator temperature was longer-1048 days.

Infectious jaundice - In dried fecal dust, the virus lived for 31 days.

Newcastle - The virus was present in chicken feces. On skin and carcass 96 days and in bare and unplucked carcass, 134-196 days viable.

Psittacosis - In fecal material the virus remained for 10 days.

Poliomyelitis - Fecal material harbored the virus for hours after passage. Storage at low temperature protected the virus to allow survival of 7-8 weeks up to 6 months. Virus found in stools from 7th day of disease to 123 days following attack. In tissue survivals of 20-30 days reported, in nasopharynx for a number of days (5-9) after onset of disease. The virus remained viable in an amoeba culture for less than 3 days.

Rabies - In brain material viability of 47 to over 68 days is reported. Exposed to liquid air destroyed in 24 hours and at high and low pH levels in a few hours.

Influenza - On human skin the virus was destroyed in less than 1 hour. In tissues at -30 C. survival was less than 6 months, lower temperature of -78 C. protected for 6 months in broth and in rabbit testes for 3 years.

Fowlpox - Two year survival in dried lesions reported.

Vaccinia - The virus from pustules survived up to 8 hours. In mouse brain survival of 6 months to 2 years is noted. In calf lymph equal survival is given.

Smallpox - In dried crusts, the virus remained for periods over a year in the light and dark.

Rinderpest - In rabbits and storage viability of 7 days.

Encephalitis viruses - Storage of 1 year in 50% glycerin, loss of virulence on drying. If frozen, survives over 3 months. Jap B in mouse brain survives at -78 C. for 6 months.

Lymphogranuloma inquinale - In rabbit testes survival of 10 months at -78 C. is reported.

Pneumoenteritis - Loss of virulence on storage is listed at 6 days if frozen and in 20 days if dried and refrigerated.

THE SURVIVAL OF ORGANISMS IN CULTURE MEDIA

One of the foremost problems in the field of microbiology has been the culturing and storage of organisms in the laboratory in such manner as to maintain viability as well as their characteristics of morphology, metabolism and virulence. A multitude of reports on this subject have been made from myriads of experiments with more or less unanimity of results. The factors involved in the storage of cultures are numerous. Several main methods have been used for maintenance of stock cultures: (1) low temperature storage; (2) drying by lyophilization or other procedure; (3) exclusion of air and maintenance of moisture; (4) use of a combination of the various methods.

The factors involved in survival may be discussed in general as to environmental factors or organism characteristics.

<u>Environmental Factors Affecting:</u>

The term "culture media" is used loosely here to cover the survival of organisms *in vitro* in media of all types whether liquid, solid or dried, in various containers under experimental conditions primarily in the laboratory.

The medium in which the organism is grown or stored plays an important role in determining the length of survival and maintenance of characteristics of organisms. The presence of inorganic buffers protect against extreme pH changes but may on occasion be toxic for some organisms. If fermentable carbohydrates are present, toxic acid, aldehyde, alcoholic or other end products might slowly pile up to kill the organism. Some salts are necessary for osmotic effect but can be toxic if in large concentrations in the medium. The organic substances in the medium may supply buffering capacity against

pH and other changes but may provide in metabolism a source of toxic end-products.

The physical state of the medium may affect survival time of organisms. Survival in liquid, on solid surface or in dried state may vary with certain organisms. The amount of medium may offer protection against physical forces of temperature and radiation or oxidation-reduction potential changes which might be detrimental to some of the anaerobes particularly.

The temperature of storage is one of the most important factors in determining length of survival. Organisms maintained at temperatures which allow metabolism of the organism to take place will not only produce toxic, limiting end-products but will age to become more susceptible to detrimental action of physical and chemical forces. Usually the higher the temperature the more rapid the death rate. Low temperature of storage obtained in refrigerators (approximately 5 C.) prevents active metabolism of most microorganisms and serves well in maintaining numbers and general characteristics of organisms. Even lower temperatures have been used, ranging from -5 C. (deep-freeze) to -75 C. (dry ice) to temperatures of liquid oxygen. In studies below the freezing point, the rate of freezing is a factor in the survival of organisms. Usually rapid freezing allows greater survival. Repeated freezing and thawing destroys many organisms probably through rupture of cell walls by formation and dissolution of the ice crystals. Presence of protein in concentration protects against such destruction.

Desiccation is usually considered as destructive to most organisms. Maintenance of cultures at low temperatures prevents loss of water content through evaporation. Materials such as cultures at room temperatures (25 C.) or incubator temperature (37 C.) may be

sealed or covered by various means including wax or rubber stoppers or screw-caps. Lyophilization, drying from the frozen state, has been exploited as a means of maintaining organisms. The suspending medium, rate of freezing, rate of drying and subsequent storage method are important factors in the success of the procedure. Usually a protein suspending medium with rapid freezing and rapid drying with the material then being sealed off under vacuum and stored at refrigerator or colder temperature gives the best results. The total dryness affects survival since a small amount of water in the end-products allows deterioration. In some instances inert gas such as nitrogen has been used instead of keeping organisms under vacuum. Storage may or may not be at low temperature. The lyophilization procedure may result in the destruction of many organisms in the preparation but those remaining viable retain their characteristics for long periods without throwing off variants.

Radiation of various types affects survival of organisms in cultures. Storage of cultures in the dark away from direct or diffuse daylight allows longer survival. Exposure of cultures to artificial sources of UV or of other radiation not only increases the death rate but increases the development of aberrant forms as mutants.

Removal of oxygen and substitution of an inert gas will prevent metabolism and allow long storage. The use of sterile mineral oil over cultures prevents desiccation and excludes oxygen as well, thus slowing down metabolism and allowing survival for long periods.

Many studies have been made on these various factors affecting survival for better maintenance of microbial cultures. The cultures have also been exposed to extremes of temperature, desiccation, pH, eH, radiation, chemicals and pressure to determine the ability of

different organisms to withstand these forces. Some of these studies are reported here.

Organism Factors Affecting:

The survival of an organism in culture media is not only dependent upon the media and other environmental factors but also upon the intrinsic characteristics of the particular organism itself. The genus, species and strain are important in that they may have characteristics providing resistance to physical and chemical forces. The presence of spores, capsules, especially rigid cell walls or other cellular components may aid in survival. The presence or development of more resistant variants or mutants may play a role in persistence. The rate and type of metabolism plays a part also in the pile-up of toxic end-products which might destroy the organism more rapidly. In all survival studies the number of organisms exposed and the age in the growth curve at time of storage or exposure are important factors in the survival or persistence of organisms.

SUMMARY

*<u>Bacillus anthracis</u> (Table C 1) Dried cultures survived 4½-35 years with good immunizing property, low temperature kept virulent forms alive for 8 years. In liquid form survival up to 1877 days in glycerin-serum at room temperatures. In sunlight killed in hours. May live for 11-14 years at 5-10 C. Liquid air killed in 6 hours, liquid hydrogen 10 hours. On solid media viability apparently low. May survive sun for 1½-4½ hours depending on season.

*<u>Bacillus species</u> (Table C 2) Dried cultures survive for 4-5 years. Liquid cultures for long periods. Spores resist sun for 5-6 hours. <u>B. globigii</u> was found to be resistant to heat, gentian violet and streptomycin. On solid media 8 month survival. At freezing temperature over 80 week survival noted.

*<u>Bacteriophage</u> (Table C 3) Dried typhoid phage lived for 26 years, others for 3 years. Resistance to heat aided by dryness. Freezing and thawing destroys phage. Lyophilization of dysentery phage inactivates much of the activity. Sunlight is toxic. Coliphage may be active for 7-17 years. When dysentery phage dried, no loss in 6 months. Phage resistant to pH changes.

*<u>Spirochetes</u> (Table C 4)

<u>Borrelia</u> - At -78 C. the organisms survive for a year. Lyophilizing destroys many cells and may live only 192 hours.

<u>Leptospira</u> - Ten month viability in tissue broth at -78 C. In temperatures of 29-42 C. survival varies upwards from 5 days to 16 months.

<u>Spirillum</u> - In mouse blood at -78 C. for 1 year.

*<u>Brucella</u> (Table C 5) When dried, cultures live 4-5 years. In liquid viability ranges from 15 days to 400 days. On solid media no loss in 8 days. On storage colony forms change. Storage at 37 C. shows 4 year

survival. Sunlight and drying lowers disease incidence. In lyophilizing high temperature lowers recovery while slow rate of drying gives better survival. Storage at 2-5 C. yields 80% viable in 100 days.

*Clostridium (Table C 6) Dried cultures live for 3-5 years. Organisms survive lyophilizing. In liquid form exposed to various changes of temperature, pressure and pH fair survival is listed. On solid media Cl. tetani lived for 38 years. Cl. botulinum showed 140 day survival at 5 C. The spore stage of these organisms protected against high temperature and sunlight for short periods.

*Corynebacterium (Table C 7) In the dried state 4-5 year viability found. The organisms resist sunlight when dried. In liquid media 6 month survival is usual. Organisms resist drying and sunlight well. On solid media 7-18 month viability reported.

*Erysipelothrix (Table C 7) When dry the cultures live for 4-5 years.

*Diplococcus (Table C 8) In dry form the organism may exist for 4-8 years depending on temperature of storage. Lyophilized strains show good survival numbers for at least 3 years. Liquid cultures live over 6 months. On solid media viability of 50 days-3 months is listed. Low pH is detrimental as are temperatures above 56 C.

*Escherichia coli (Table C 9) Survival in dry state of 4-5 to over 10 years is listed. Early studies showed shorter periods. Freezing and thawing for lyophilizing destroyed many. In liquid exposed to increased temperature, freezing temperatures and chemicals, short periods of survival (in hours) are shown. In ordinary cultures at room temperature, viability over 1 year is found. Increasing salt concentrations destroy the cells. Very low temperatures destroy some cells rapidly (-195 C.). A temperature of 69 C. with high humidity is resisted for 7-10 hours. On solid media 91 day to over 11 month survivals are listed. Sunlight during various seasons is resisted for 1½ to 4½ hours.

Viability for 14 years noted in one instance at R.T. in dark. Wide variations in temperature affect survival adversely.

*Microorganisms (Table C 10)

Alcaligenes - In dried form, survival of 4-5 years is reported.

Aerobacter - For 4-5 years in dried state, 31 days dried on paper at 37 C. Reports suggest the organism resists alkaline pH.

Hemophilus - Various species including H. pertussis lived for 5 years in dry state. In blood broth at -15 to 20 C. a few hours. On agar for 4-8 months.

Klebsiella - When dried, survival of 4-5 years listed, in serum at 37 C, 43 days, while in sealed tubes on agar 12-13 year viability has been demonstrated.

Lactobacillus - At 37 C. in dry state poor survival but at lower temperatures 3-4 year survival is shown. It resists liquid hydrogen for 7 hours and -10 to -80 C. for long periods. Rapid freezing aids survival. On solid media, 2 year viability was found.

Proteus - When dried, 4-5 year survival. In liquids good survival was reported. On solid media, 8 month viability found for some, 4-5 years for others and 19 years when on agar in sealed tubes at R.T.

Pseudomonas - Survival similar to Proteus, 4-5 years when dried, in liquid and on agar good survival found. It is slowly destroyed by pH up to 11.5.

Flavobacterium - In liquid media at -5 to 15 C., survival of less than 77 days revealed.

Achromobacter - Grows at low temperatures (0 C).

Azotobacter - Viability of 10 years on dried dextrin agar is reported.

Malleomyces - At low temperatures of 1-4 C. under vacuum, 25 month survival is listed.

Erwinia - Low RH aids survival in exudates.

*Microorganisms (General) (Table C 11) Generalizations on effects of temperature, freezing, drying are given. Better survival with covering of paraffin oil is indicated..

*Mycobacterium (Table C 12) In dried state reports vary from 6-12 months to 4-5 years and one report of 17 years following vacuum desiccation. In liquid preparations, reports of several months to several years are reported. On the various isolation media, 4-8 month survival up to 6 years is listed. Low temperatures gave poor viability. Drying gives good survival. Low pH destroys but not too rapidly.

*Neisseria - (Table C 13) These organisms are very sensitive to drying and sunlight. Under freeze-drying conditions, 4-5 years of survival listed and up to 18 years in others. But in nature in sunlight only a few hours may kill. Liquid cultures of the meningococcus at low temperature (frozen) survive for months and up to 2 years. In serum, 16 month survival is listed. On solid media it lives for 8-27 weeks at low temperatures. The gonococcus survival is poorer except when dried, 4-5 years up to 18 years. In liquid media 7-8 week survival is listed, pH of 7.4-7.6 allow best survival. On solid media, 8 month viability is given.

*Pasteurella (Table C 14) Dried materials live 3 to 4 days when not in sun, 3-4 hours in sun. When dried in lab for stock, 4-5 year survival obtained. Liquid materials of P. pestis may survive a few months at freezing temperatures. Solid media survival of 20-25 years is reported. P. tularensis may live for months in frozen conditions. Other Pasteurella strins have somewhat similar persistence characteristics.

*Protozoa and Metazoa

Entamoeba - Three day to 3 week viability in Ringer's and other solutions and 10 days in powdered starch medium.

Plasmodium - In chicken red cell suspension, 72 hours without loss.

Trichomonas - Survival of 4-13 days at 25-37 C. in media; at low temperature, 2-3 week survival. Only 6 hours when dried.

Trypanosomes - In blood agar tubes, various species lived for 3-4 months at 25 C.; survival varied at freezing temperature of a few hours to a few months.

Schistasoma - Ten to 18 day persistence *in vitro* in serum.

Leishmania - Four month persistence in blood agar at room temperature.

Ascaris - Freezing temperatures inactivated in 6-20 days; high temperatures (60-70 C.) destroyed in a few minutes.

**Rickettsia* (Table C 16) For lyophilizing, surcrose was found effective. At room temperatures survival of a few hours to 1 week are recorded; at refrigerator temperatures, 2 week viability is listed while at freezing temperatures near -20 C, several month viability is found. With glycerol added, 10 month at -10 C. is reported.

**Salmonella species* (Table C 17) When dried at natural temperatures several hours of viability is found but lyophilizing allows viability of 4-5 years or as long as 10 years. In liquid cultures, 3-4 weeks is the usual report with occasional suggestion of 12 month viability. On solid media survival of nearly 2 years on blood gelatin and 98 day viability on gelatin are reported.

**Salmonella typhosa* (Table C 18) When desiccated, thin layers survived 5-15 days and thick layers lived for months. In liquid media such as saline survival over 6 days was found, at -20 C., 4½ months are listed and 10 years in tryptic digest. Resistance to liquid air, ultra violet, heat and freezing are given. On solid media, 91 day to over 8 month resistance was found. Other survival of 3 years to 8 years is listed on artificial media at room temperatures while lyophilized strains survived for about 4 years.

*Serratia (Table C 19) Lyophilized strains lived for 4-5 years. In liquid, marscescens may survive for 20 years. Cetrifuging destroys cells as well as radiation from the sun.

*Shigella (Table C 20) Desiccated organisms may live only 20-25 days, but lyophilized cultures live for 4-5 years. Liquid or agar cultures may persist for 3-5 years. The organisms may live at 37 C. for 2 weeks. Sunlight destroys cells in a few hours but cultures remain viable for 900-1500 days in the dark.

*Staphylococcus (Micrococcus) (Table C 21) Dried cultures have remained viable for 30 years. Stock lab cultures on media sealed remained alive for 11-12 years. At room temperatures, cultures remain alive for 1½-2 years. Lyophilized strains were alive for 4-5 years. Exposure to saline, freezing, vacuum drying, extreme freezing temperatures result in lessened survival.

*Streptococcus (Table C 22) Dried cultures may live over 97 days but if lyophilized, viability of 4-7 years has been reported. Liquid cultures may live 30-60 days, if tissue added then lives 11-12 months. On solid media sealed tube cultures lived 11-12 years. Increased humidity over cultures lowers survival from 3 years to 8 weeks.

*Treponema (Table C 23) When dried under varying conditions of humidity and temperature, the cells were killed in several hours to several days. Survival at freezing temperature in media for several weeks to 2 months. At sub-freezing temperatures survival of 1-3 years was obtained when tissue added. Exposure effects of heat, pH changes and freezing temperatures are given.

*Vibrio comma (Table C 24) Dried preparations survived 4 years. Lyophilized preparations were viable for about 4-5 years. Liquid cultures lived for 4-5 weeks. On solid media lived under lab conditions for 6 weeks to 20 weeks. Some agar cultures dried, lived only 2-11 days.

At extremely low sub-freezing temperatures, viability for over a year was found.

*Viruses (Table C 25)

Herpes - Dried virus at -5 C. survived over a year; at 37 C. for 2 months. Lyophilized, survival given at 4 weeks only. Liquid preparations at 37 C. for 100 hours and at 42.5 C. for 30 to 80 hours. UV radiation destroyed in 10 minutes. At -70 C. viability of over 1 year was found.

Hoof and Mouth - In dried form survived high temperatures for short periods. Ten day viability at room temperature is listed. In liquid preparations such as blood 2-5 days viability found; in buffered lymph over 2 year viability, high pH and repeated freezing did not destroy in 124 days. In solid media, 162 day survival is reported.

Influenza - Dried in talc for 30 minutes destroyed virus. Lyophilized, viable and infectious for 14 months. At -78 C. viability of 6 months to 3 years is noted in broth plus tissue. At -20 C. less than 6 month survival is recorded. Low pH was found to be detrimental. Temperatures over 40 C. destroyed the virus quickly.

Poliomyelitis - When dry, 52 C. for 30 minutes necessary for destruction. In glycerin, survival of 6 years is reported by one, others report over 2 year survival in glycerin. Concentration of glycerin and storage temperature are important. At 38 C., virus destroyed in 7 days.

Smallpox - Dried and stored at 37 C., 80 day survival but at 4-6 C. only 24 hour survival. In media, viable only 30 minutes at 35 C.

Vaccinia - Dried virus at 4 C. lived 12-18 months; 229 days when dried, temperature not given; lyophilized, lived for 10 months. In glycerin, at -70 C. 21 month survival, at refrigerator temperature it was avirulent in 12 months. In lymph for 2 years; in

allantois at low temperature, for 15 years. Dry lymph in tropics survived for 18 years.

Tobacco Mosaic - When dried it remained active for many years.

Laryngotracheitis - The virus remained active for 3 years following lyophilization and storage at 4 C.

Lymphogranuloma inguinale - Ten month viability has been reported for the virus in rabbit testes in infusion broth at -78 C. At 37 C. viability of 2-4 days reported with 56 C. destroying in 10 minutes and -70 C. allowing viability for over a year.

Lymphocytic choriomeningitis - Frozen dried material at 5 C. remained active for over a year.

Meningopneumonitis - Viability for 3 years in broth plus tissue at -78 C.

Encephalitis, St. Louis - Frozen dried preparations at 5 C. were active for over 833 days. At 40 C. and pH 8.4, 3 week viability was found. Heat at 56 C. for 30 minutes necessary for destruction.

Encephalitis, Jab B - In tissue plus serum at -20 C., 6-12 month survival reported. pH levels above 7 inactivated the virus rapidly, 60-70 C. destroyed it in 10 minutes.

Encephalitis, equine - Acid pH inactivated it readily as did alkaline pH levels.

Enteritis - At pH 7, the virus survived only 20 days.

Measles - In 50% glycerin, the virus existed for at least 3 months.

Mumps - At -20 to 30 C., the virus was viable for only 6 months or less. Acid and alkaline pH levels inactivate readily.

Newcastle - In 50% glycerin at pH 7.6, the virus was viable for 95 days at 25 C. and at 5 C. was viable for a year. At 37 C., one report lists 126 days of activity.

Psittacosis - Viability in broth for 29 days at lab temperatures, while at -70 C. for over 2 years active virus was present.

Rabies - The virus is apparently quite stable, surviving 56 C. for an hour, -185 C. for 3 months and living at 25 C. for several weeks. Extraction with ether at -65 C. still gives active virus after 1 year.

Coxsackie - Temperatures of 53-55 C. for 30 minutes inactivate. Acid and alkaline pH levels inactivate in 1 day.

Yellow Fever - Aqueous suspensions are viable for 10 days, with glycerol, 8 months viability is found. Dried and frozen the virus is active for years.

Cowpox - At sub-freezing temperatures survival of 1-4 days is revealed.

Rinderpest - Desiccated virus viable for 15 days. In tissue at 4 C. over 4 month survival.

"Cold" virus - At 4 C., the filtrates are active for 3 days, at 10 C. for 27 days and at -76 C. for 2 years.

*Yeasts, Molds and Fungi (Table C 26)

Actinomyces - Dried cultures survive from 1-5 years.

Saccharomyces - When dried the cells are quite resistant. Ten month survival in plaster of paris. Lyophilized cultures were viable for 1-2 years. In liquid cultures survival of 5 weeks to over 160 weeks at -15 C. are reported. In 10% sucrose, 8-10 year viability found. On solid media at -70 C., survival of a week is listed. At -10 C. over a year survival is reported while at 37 C. 5 month viability was found. Some grow at refrigerator temperatures.

Aspergillus - At sub-freezing temperatures survival of 4 days was observed, while at 7 C. on agar over 2½ year viability was found. At 25 C. in the dark, 6 year storage was reported for one while others lived 10-16 years.

Epidermophytes - Survied for several weeks at sub-freezing temperatures.

Blastomyces - Over 20 months at 25 C. on agar covered with oil.

Candida - Survival of 20 months at 25 C. on agar covered with oil.

Coccidioides - On agar at 25 C., survival of 20 months when covered with oil.

Cryptococcus - Recovery of 20 months on agar slants covered with oil stored at 25 C.

Nocardia - 20 month survival observed.

Streptothrix - 420 day survival reported.

Others - Many fungi such as Penicillium, Rhizopus and others survived over 2½ years on agar at 7 C.

SURVIVAL OF ORGANISMS IN FOOD

One of the main avenues of invasion of disease producing organisms and toxins is by the oral route. Many, but not all, pathogens can infect this way and not all of those that enter by that route are true intestinal pathogens in the strict sense of the word. Poliomyelitis virus would be an example.

Food such as green vegetables and fruit may get contaminated in the gardens from fecal material or handling. If eaten raw without proper washing the organisms of typhoid, dysentery and certain parasites of protozoa and worm types may cause infection.

One of the major methods by which pathogens get into food is by improper, unsanitary methods of handling. In one way or another, the organism in fecal material or other excreta get from humans or animals into the food. Very few withstand mild heat. Proper cooking would destroy all of the potential pathogens.

In some instances, the pathogens are present in animal materials used as food. That is the milk, milk products or meat may contain animal pathogens with which the animal is infected. Some of these pathogens may also infect humans. If the organisms persist in the milk products which are not treated by pasteurization (milk) or proper cooking as in the case of meat, the infection may occur. Sometimes the pathogens transmitted by the milk or meat are from the food handlers and not from the animals at all.

A few of the potential pathogens may actually grow in the food. This increase in numbers of organisms may result in such numbers as to cause "food poisoning" when eaten. Examples would be Salmonella organisms. A few such as the Staphylococcus and _Cl_. _botulinum_ organisms produce toxins in the food which also cause "food poisoning".

The factors affecting survival of organisms in food may be grouped as to (1) food factors affecting and (2) organism factors affecting.

Food Factors Affecting:

The general type of food product will affect the survival of any organism in it. Particular characteristics would be: (1) amount of moisture present to allow or prevent multiplication of the organism; (2) presence or absence of antagonistic organisms; (3) the use of the food by the organism as nutrient increasing the number and for producing detrimental end-products for survival; (4) the pH of the food; (5) the presence of inhibiting quantities of sugar, salt, spices or other preservatives; (6) the temperature under which it is stored; (7) if frozen, the rate of freezing and (8) the amount of light or radiation.

Organism Factors Affecting:

An organism may survive or persist in foods for varying lengths of time depending upon (1) the inherent resistance of the genus and species under test; (2) the particular strain of organism studies; (3) the presence of a protective stage of the organism such as a spore; (4) the presence of a protective covering on the cell, such as a capsule; (5) the age (in the growth curve) of the inoculum; (6) the numbers of organisms inoculated; (7) the ability of the organism to multiply in the food under the conditions presented.

SUMMARY

*Bacillus (Table F 1) Bacillus anthracis was found to survive in milk for 10 years, was present on oats and on corn roots for 50 days and beans for 6-11 days. Other Bacillus species were found commonly in margarine and to survive on fruit for long periods at low temperatures.

*Brucella (Table F 2) In milk the bovine strain lived for 5-10 days. In sheep milk persistence of 22-40 days was observed at refrigerator temperatures. In dairy products such as butter, 142 days survival and with cheese, 1-2 months most common but as long as 1 year was listed. Ice cream kept for 5-7 years at -23 C. still had Brucella present. In unsmoked ham survival of 21 days was reported. Brucella survive for an hour in wines and up to 3 days in beer.

*Clostridium (Table F 3) The organisms are present in cheese and other milk products, on vegetables, meats and on fish, usually in the spore states. Clostridium botulinum was able to exist for over 2 years on vegetables at -16 C. as well as a large variety of foods at similar temperatures. Low pH inhibits the organisms as does high temperature.

*Coliforms (Table F 4) The organism may be present in milk and dairy products for long periods depending on pH and temperature. Some cheeses harbor it for 12 months or more. In frozen eggs E. coli recovered, even after 5 years. It is present in sea foods and may live in sausage for 13 days. Vegetable surfaces may have the organism on for long periods. Storage at -4 F. allowed survival for a year. Fruit surfaces are also contaminated and can live for 2-4 months at low temperatures. Beverages such as milk and beer may have the organism present.

*Micrococcus (Table F 5) Micrococcus species were present in milk, eggs, meat, sauces, on vegetables and fruits. Some 56% of margarine

samples had Micrococcus species present. In eggs at -9 C. survival for 1 year is listed. In meat, survival of over 60 days at 22-37 C. was reported. Some survival of 16-144 hours in mayonnaise was found even at low pH. On vegetables at -17 C. 8 month survival is reported. Fruit at -18 C. contained organisms for 6 months while juices at -4 C. lost viable counts at 50 hours.

*<u>Microorganisms</u> (Table F 6)

<u>Corynebacterium</u> - In frozen cream for over 4 days, butter for 1 month and sausages for 24 hours.

<u>Lactobacillus</u> - Present in milk for long periods and on peas for over 2 years at 15 F.; in butter for 275-462 days.

<u>Rickettsia</u> - In milk for at least 24 hours and probably 7-30 days. Cheese for 46 days and butter for 41 days.

<u>Achromobacter</u> - Viable in butter for 239 days.

<u>Bacterium linens</u> - 4 month survival in cheddar cheese at low temperature and pH.

<u>Trichinella</u> - In pork, survival for a few minutes to 36 hours at sub-freezing temperatures.

<u>Pasteurella tularensis</u> - Present in grain and food contaminated with rat excreta.

<u>Pseudomonas</u> - On plants for 69 days.

<u>Proteus</u> - In fruit juices at sub-freezing temperature for almost a month.

*<u>Microorganisms (General)</u> (Table F 7) The general effects of low temperature in keeping bacterial flora of milk and milk products low are given. Similar reports are given for eggs. Temperature and humidity effects on survival in meat are shown as well as temperature reduction of organisms in fish. Organisms were present in frozen vegetables for over 4 years at -18 C. Temperatures of 65-80 C. did not destroy organisms. Low temperature and moist soil plus organic matter allow

pathogens to survive. On fruit surfaces many organisms may be present. They survive at low temperature for long periods up to 3 years. Low pH destroys them rapidly.

*Mycobacterium tuberculosis (Table F 8) In milk, survival of 10 days to 2 years is listed. Low temperature allows long survival. Sour milk destroys organism. Temperatures of 60-80 C. kill rapidly. In dairy products at 15-22 C., 2-30 day viability is listed depending upon pH. Cheese may harbor the organism for 2 weeks to nearly a year depending on type (of cheese). Ice cream kept for 4-6½ years yielded live organisms. The organism survived pasteurization in butter. Several reports on food suggest that fat protects organisms.

*Salmonella species (Table F 9) The major proportion of reports on organisms in food dwells on Salmonella species. In milk, Salmonella types may survive at refrigerator temperatures about 170-324 days. Many experiments with lowered pH show decreased survival. At pH 4.7 for 11-63 days and pH 4.2, no survival. Different species and strains vary as to sensitivity to acid. Sterile milk plus Salmonella give good survival suggesting antagonism may destroy them. In dairy products such as butter 117 day survival is suggested, for curds only 48-96 hours, for ice cream about 6-7 years at -23 C., in butter 49 to 212 days, buttermilk for 10-15 days, cheese for 24-30 days or even to 6-10 months, depending on the species and inoculum size.

In eggs at -1 to -18 C. some 11 month survival reported, while dried egg at 35 F. allowed viable forms at 65 weeks. Egg albumin was contaminated almost always and the organisms lived for 20 days at 120 F.

In meats of all types, Salmonella were present in some 1 to 26% of samples. In chicken at -25 C., 270 day survival is listed. In corned beef, 60 day viability is given. In oysters, 4 to 24 day survival is given. In other sea foods 4-40 day survival was found at

low temperature.

In sauces such as salad dressing, survival of 1 to 144 hours was found. In cereals and breads 4½-6 month survival. On vegetables Salmonella may stay for a few days to several weeks at body and refrigerator temperatures or up to 25-31 days at room temperature. Several reports suggest 200 day-3 year persistence in canned vegetables. In frozen foods, 12 week survival. On greens for salad, 12 hour to 21 day survival has been observed. In or on fruit these organisms live for a few days in low pH juices or as long as 1-3 months in frozen fruit or for 68 days on surfaces. In beverages survival of Salmonella may be for 38 days or more in cold beer or for 1 hour in wine.

*Shigella species (Table F 10) In milk at refrigerator temperature, 18-27 day survival is listed with 53 days in pH 4.8 milk but only 3 days at lower pH. In milk products survival varies from curds with no survival to butter at 18 day viability. Cheese may harbor the Shigella for 9 days. Eggs may be contaminated for 3 months at -9 C. Meats contain viable organisms for over 3 weeks. Cereals and bread may have Shigella present for 1 day up to 45 days with decreasing temperature. Fruit have been contaminated for 2-10 days.

*Streptococcus species (Table F 11) Some of these organisms are quite common in milk, but length of survival apparently is not too long. Reports suggest 8-48 hours in fresh and sterilized milks. In dairy products pyogenic streptococci have been found for varying periods such as in cheese from 9 days to over 18 weeks depending on type of cheese and in butter for 17 days. Other streptococci may exist for 6 months in butter. Ice cream may be contaminated for 12 hours to 18 days. Eggs may contain these organisms for a few hours while meats have been harboring them for 13-60 days. Frozen vegetables may have streptococci in them for a year.

*Vibrio species (Table F 12) The cholera organism survives in milk for short periods of a few hours at room temperature to 8 days in sterilized milk. In dairy products such as butter, viable organisms have been found for 21-over 98 days with low temperatures extending the period of survival. Cheese does not allow very long survival with reports varying from 8 hours to 4-5 weeks. Curds and whey showed poor survival. In fish eggs, the vibrios lived from 12 hours to over 8 days at low temperatures. The organisms were present in various fish and meat preparations for varying periods. In fish, the usual survival was for a few hours to a few days. When salted and/or at low temperature low viability was found in fish. In meat, a report of 45 weeks was found but another report suggested 2 weeks at 3-8 C and 7-10 days in hot weather. The vibrios survive in sauces from 1 hour to about 24 hours. In cereals, 8-15 hours and on vegetables, for 4-5 weeks; on fruit as long as 4 days are also reported.

*Viruses (Table F 13)

Poliomyelitis - The virus resists heat in milk better than in water. In butter, 91 day viability was observed. The virus was found on fresh fruit and vegetables.

Foot and Mouth - The virus has been found in milk. It exists in beef at -4 C. for 24 hours and at -20 C. for 4 months. Some reports of its presence on cereals suggest 4-20 week persistence.

Newcastle - In eggs, survival of 126-538 days is listed. At 36 C. over 100 days and at 3-6 C. over 500 day survival was found. In mash, 56 to over 538 day viability was observed. At pH 5 and 37 C. 56 days was the extent of persistence while at pH 5 and 3-6 C. over 500 day existence of virus was observed.

Fowl Pox - In dried eggs, survival of 1928-3598 days (10 years) is reported.

Encephalitis, Jap B - In eggs at 4 C., only 6 hour survival was found.

Pigeon Pox - In dried eggs, viability of 1099-3605 days has been demonstrated.

*Yeast and Mold (Table F 14) Yeasts are reported in milk and in margarine (46% of samples). Vegetables contain yeasts after being frozen but 90% are destroyed. Yeasts survive for 7 months to 3 years on or in fruit at low temperature. In foods, in general, yeasts survive 3-15 months.

Molds or fungi may be found in 42% of margarine samples. In or on vegetables they may live for 16 months but 90% are destroyed by the freezing process.

On fruit or in fruit juices at low temperature, viability of 7 months to 3 years has been demonstrated.

SURVIVAL OF ORGANISMS IN OR ON INSECTS

The duration of survival of potentially pathogenic as well as saprophytic organisms in or on insects of various types has received considerable interest. Some insects have been found to play an important role in the transmission of certain diseases. Below is given a classification of arthropods and the diseases in which they play an important medical role. The common names for the insects are given within the parentheses and the list of diseases in which the particular insects play a role are capitalized.

CLASSIFICATION OF ARTHROPODS OF MEDICAL IMPORTANCE

PHYLUM-ARTHROPODA

I. Class - Insecta (Hexapoda) - insects

  A. Order - Orthoptera (cockroaches)

  B. Order - Hemiptera (true bugs)

   1. *Triatoma* spp. (reduviid bugs) - CHAGAS DISEASE
   2. Bedbugs

  C. Order - Anoplura (sucking lice)

   1. *Phthirus pubis* (pubic or crab louse)
   2. *Pediculus humanus* capitis (head louse)
   3. *Pediculus humanus corporis* (body louse) - EPIDEMIC RELAPSING FEVER, EPIDEMIC TYPHUS AND TRENCH FEVER.

  D. Order - Coleoptera (beetles)

  E. Order - Siphonaptera (fleas)

   1. *Xenopsylla cheopis* (rat flea) - PLAGUE, ENDEMIC TYPHUS.
   2. *Ctenocephalides canis* (dog fleas) - DIPYLIDIASIS and HYMENOLEPIASIS.
   3. *Tunga penetrans* (Chigoe flea).

  F. Order - Hymenoptera (bees and wasps)

  G. Order - Lepidoptera (butterflies and moths)

H. Order - Diptera (flies & mosquitoes)

1. Anopheles spp. (mosquitoes) - MALARIA and FILARIASIS
2. Culex spp. (mosquitoes) - FILARIASIS and ENCEPHALITIS
3. Aedes spp. (mosquitoes) - YELLOW FEVER, DENGUE FEVER, and FILARIASIS
4. Mansonia spp. (mosquitoes) - ENCEPHALITIS and FILARIASIS
5. Culiseta spp. (mosquitoes) - ENCEPHALITIS
6. Hemagogus spp. (mosquitoes) - JUNGLE YELLOW FEVER
7. Simulium spp. (black flies) - ONCHOCERCIASIS
8. Phlebotomus spp. (sand flies) - SANDFLY FEVER, VERRUGA PERUANA and LEISHMANIASIS
9. Culicoides spp. (biting gnats) - MANSONELLIASIS, and ACANTHOCHEILONEMIASIS
10. Chrysops spp. (deer flies) - TULAREMIA and LOIASIS
11. Glossina spp. (tsetse flies) - AFRICAN SLEEPING SICKNESS
12. Hippelates spp. (eye gnats) - YAWS

II. Class - Arachnida

A. Order - Acarina (ticks and mites)

1. Ornithodorus spp. (soft ticks) - ENDEMIC RELAPSING FEVER
2. Dermacentor spp. (hard ticks) SPOTTED FEVER, TULAREMIA, COLORADO TICK FEVER, and TICK PARALYSIS
3. Ixodes spp. (hard ticks) - RUSSIAN SPRING-SUMMER ENCEPHALITIS
4. Rhipicephalus spp. (hard ticks) - FIEVRE BOUTONNEUSE and KENYA TYPHUS
5. Trombicula spp. (mites) - SCRUB TYPHUS
6. Allodermanyssus spp.(mites) - RICKETTSIALPOX
7. Sarcoptes spp. (scabies mites) - SCABIES
8. Bdellonyssus spp. (tropical rat mites)
9. Eutrombicula spp. (chiggers)
10. Demodex spp. (follicle mites)
11. Pediculoides spp. (grain itch mites)

B. Order - Araneida (spiders)

1. Latrodectus spp. (black widow spiders)

C. Order - Scorpionida (scorpions)

There are some 10,000 kinds of mites, ticks and insects which affect man with bites or allergic reactions and infect man with one or another type of disease. Some of these "insects" carry disease by accident or only occasionally. Some of the diseases are not directly man to man through insects but may be carried among cattle and other livestock as well as wild animals, then from these reservoirs back to man.

Some insects are considered only as mechanical carriers. This is where they walk over infected material and/or eat the contaminated materials and then transfer the infectious orgaaism by defecation, vomiting or merely crawling over food or susceptible host. Other insects act as mechanical vectors by picking up organisms when biting an infected human or animal and carrying on itself until it bites a new host.

A different and more complex relationship exists in some insects where the organism grows or multiplies in the insect and then is transmitted. In certain insects the organism may go through the life cycles and continue to be infectious following defecation or vomiting. In a few instances the parasite may go through a portion of its life cycle in the insect before becoming infectious for humans or animals. This type of relationship is difficult to assess in survival and persistence studies undertaken here.

The organisms carried by insects may be viruses, bacteria, fungi, protozoa and even the larger roundworms and tapeworms. Some are transmitted by the insect. Experimentally, some insects have been contaminated with organisms and the rate of survival studied but under field conditions the organism may or may not ever be found to be associated with insects in general and the one under study in particular.

The following tables list numerous pathogenic and saprophytic organisms found associated with insects. For the most part, data on medically important microorganisms are presented. In some cases organisms closely related to the pathogens have been included for comparative purposes. Wherever exact data on inoculum size and recovery rate in experimental studies were available the information was recorded. Experimental transmissions or survivals have been

noted as such (exptl.). Where studies were made under field conditions and the organism was found, recovery has been recorded as "present". Where no numerical figures or quantitative studies were available and the organism was found, recovery has also been recorded as "present" In some instances studies were made to see if the insects could transmit a particular disease organism. If the results were positive it has been recorded as "transmitted".

Factors of Nature Affecting:

The climate, namely temperature and relative humidity play a role in survival of some organisms on insects. Low RH and high temperature adversely affect many organisms. The seasons of the year as well as rainfall are important. Some diseases are not important in certain areas because the insect vectors cannot survive or live there. Certain factors such as presence of food and favorable climate as well as intermediate hosts are important in the survival of the insect as well as the organism.

Factors of Insect Affecting:

Insects vary in their importance as vectors of pathogenic organisms because of their living habits. Some do not live near places where the organisms exist. Others while living close to humans and their organisms do not feed on contaminated material whether it be food, excreta or by biting or sucking on infected hosts. Thus, they do not play an important role as vectors. Some organisms are carried by some insects for varying periods but are not transmitted for various reasons such as the numbers might be too small, or the organism must be transmitted into the blood stream and the insect does not bite, or the organism is not in the biting-parts. Some insects do not provide proper food or conditions

for survival of the organism. It might contain antagonistic chemicals as well as other antagonistic organisms which would prevent survival.

Factors of Organism Affecting:

The inherent properties of an individual genus, species and strain may determine whether it survives in or on a particular insect for any length of time. Presence of a spore or capsule or other resistant cell components help in survival or persistence of the organism. Some cell walls are more resistant to the drying conditions of air and aid in persistence of the organism when on insects. Other organisms can grow in insects thus providing greater numbers and longer survival. Others may resist insect digestion and antagonistic organisms for survival while others may pass into new generations by transovarian passage.

SUMMARY

**Bacillus (Table I 1) The important organism of this group (B. anthracis) was studied in bedbugs, beetles, cockroaches, flies and ticks. It was found present in bedbug feces, experimentally it remained in stomach and feces for 24-96 hours. In beetles the organism was reported present as was true for cockroaches. The organism was found present and could be transmitted by flies, passing through the life cycle. This was true also in ticks, the organism being in feces for at least 100 d.

**Borrelia (Table I 2) Organisms of this group are reported in bedbugs, lice, reduviids and ticks. Experimental studies with bedbugs indicated survival in but no transmission by bite. In lice B. recurrentis existed for at least 19 days and could be transmitted by Pediculus corporis. In triatoma B. duttoni lived for 6 days. Much

work was done with many species of ticks and with several types of Borrelia. B. recurrentis lived for 5-6.5 years in Ornithodoros species and could be transmitted by numerous species. Other Borrelia are reported as present and transmitted by Ornithodoros, Rhipecephalus and Argas genera.

**Brucella (Table I 3) Reports are present on bedbugs, cockroaches, fleas, flies and ticks. Bedbugs were host to the organism for over 3 months but not transmitted by bite. They lived for only 24 hours in roach feces. Organisms were found present in flea feces but not transmitted. Flies harbored the organism for over 96 hours in the gut. In ticks, the Brucella organisms lived for over 3 months passing through to eggs and larvae and being transmitted by bite.

**Clostridium (Table I 4) Studies were made on beetles and cockroaches. Cl. tetani and Clostridia of the gas gangrene group were reported present in the feces of selected beetles and roaches.

**"Coliforms" (Table I 5) Findings are discussed for beetles, cockroaches, and flies. Most reports indicate coliform organisms (E. coli, A. aerogenes and paracolon organisms) present in the insects listed with transmission by the Periplaneta americana roach. Particular interest was shown in flies where growth in the flies was reported and increased numbers in unsanitary areas.

**Corynebacterium (Table I 6) Studies are reported on these organisms in beetles, cockroaches and flies. Diphtheroids were found in beetles and roaches while the diphtheria organism was observed in the intestinal tract and on legs of roaches. Experimental survivals in flies suggested survival of a few hours on legs and wings to slightly over 24-50 hours in the intestinal tract.

**Diplococcus (Table I 7) The diplococcus of pneumonia was reported present in cockroaches, fleas and in lice. It was reported present

on legs of roaches, in feces of roaches, fleas and lice.

**and Streptococcus (Table I 7) Various streptococcus species were found in cockroaches, flies and reduviids. Reports are on S. fecalis, equinus and pyogenes as being present. Transmission of S. fecalis by triatoma is indicated.

**Fungi, Yeasts and Molds (Table I 8) Brief data is presented on these microorganisms in cockroaches. Experimental inoculation of torula suggested recoveries up to 6 days.

**Malleomyces (Table I 9) Studies on beetles, cockroaches, fleas, and mosquitoes are listed. It is reported present in feces of all but mosquitoes. In fleas survival is given at 50 days with transmission for M. pseudomallei with transmission also listed for Aedes aegypti.

**Micrococcus (Table I 10) Brief notes are made for the presence of various Micrococcus species in beetles, cockroaches, flies, lice, mosquitoes and ticks. Survival studies are listed for Staph. aureus in the gut (8 days) and feces of flies at 3-5 days. Staph. citreus passed through the life cycle and lived for 9 days after maturity. Lice were able to transmit Micrococci. Staph. aureus lived for at least 24 hours but not 7 days in the gut of Aedes aegypti.

**Microorganisms (Table I 11) This section contains a few isolated reports on several gram negative organisms including Klebsiella, Proteus, Pseudomonas, Serratia and Neisseria.

Klebsiella - found to be present in feces of beetles and roaches.

Proteus - present and transmitted by roaches; present in flies.

Pseudomonas - present and transmitted by roaches; present, passes through life cycle of flies and transmitted by flies.

Serratia - experimental throughout life of roach; exptl. in flies lived 4-5 days in crop, 18 days in intestines but only one day in pupae of Musca domestica.

**Mycobacterium (Table I 12) Reports are listed on the presence of M. tuberculosis in beetles, cockroaches, and flies; and for M. leprae in bedbugs, cockroaches, flies, lice and mosquitoes. The studies with M. tuberculosis reveal it to be present in beetles, present for 2-5 days and transmitted by roaches, present in flies, survive 13 days in flies intestines and feces and to be transmitted by flies. M. leprae (or similar organism) is reported to be present for 5-16 days on and in bedbugs, to exist up to 169 days in roaches, to be present in the stomach of fleas and to live for several days in flies and mosquitoes as well as being found in lice.

**Pasteurella (Table I 13) Various insects including bedbugs, fleas, flies, lice, mites, mosquitoes and ticks have been recorded as harboring Pasteurella organisms for varying lengths of time. The important organisms are Pasteurella pestis of plague and Pasteurella tularensis of tularemia.

P. pestis - The insect of importance is the flea. History has recorded its role in the transmission of plague from rat to man. Representative reports reveal its survival and growth in fleas with survival in the flea for periods up to 21 days and 4-5 weeks in flea feces. The organism was also found in ticks and to be transmitted by ticks.

P. tularensis - In bedbugs survival was for 136 days with transmission. Fleas were found to contain the organism and transmit it as well. The same was true for certain flies, lice, mites and mosquitoes. Tularemia is transmitted more often through ticks. The organism survived in Ornithodoros for 674-701 days, was able to survive the life cycle of Dermacentor and could be found in Ixodes.

**Protozoa and Metazoa (Table I 14) Data are presented on bedbugs, cockroaches, flies, lice, mosquitoes, reduviids and ticks.

Trypanosomes - reported transmitted by bedbugs, transmitted by

flies (Glossina species), lice, mosquitoes and reduviids with survival in the triatoma for 2-6 days.

Leishmania - found to be present and transmitted by flies (Phlebotamus) and survived in reduviids for one day with 25 day survival in ticks plus transmission.

Endamoeba - present in roaches for 72 hours, present in flies for short periods (2-3 days) at most.

Giardia - found in roaches and survived up to 12 days experimentally, also present in flies for a few days.

Chilomastix - present in flies.

Endolimax - present in flies

Worms - hookworm found in roaches and flies, tapeworms reported in roaches, roundworms present in roaches and flies.

Filaria - present and transmitted by mosquitoes.

Plasmodia - in mosquitoes with survival and transmission given under varying conditions of temperature and relative humidity in various mosquitoes.

Babesia - present and transmitted by ticks.

**Rickettsia (Table I 15) Studies on Rickettsia in insects were limited to a few reports in bedbugs, fleas, lice and mites with many reports on ticks. Rickettsiae were found to be present in bedbugs, survive from 24 hours to 10 days but not to be transmitted. Rickettsia of typhus fever were found present in fleas, could survive up to 52 days within the flea and be transmitted. Survival studies of Rickettsia in lice and louse excrement are reported with persistence for 10 days to 4 months. In feces under varying conditions of temperature and humidity the Rickettsia lived for 11-12 days up to 147 days and could be transmitted to susceptible animals. Typhus fever and other Rickettsia were present naturally and could be transmitted by numerous types

of mites. Data presented on survival and persistence in ticks are extensive. Typhus fever, rocky mountain spotted fever, bullis fever and Q fever Rickettsia constitute the major reports. R. rickettsi is reported surviving 345 days. It is present in numerous types of ticks naturally and experimentally transmitted to susceptible animals. Other rickettsia (RMSF) pass through the life cycle and may survive over 1000 days in ticks. Coxiella burneti is reported present and transmitted by ticks surviving 600-900 days and being transmitted 400-700 days. In tick feces viability up to 586 days is listed.

**Salmonella (Table I 16) These organisms are reported from bedbugs, cockroaches, fleas, especially from flies, and in one or two reports from lice, mosquitoes and ticks. Their importance is in intestinal diseases where the organisms may be deposited on food in feces primarily. In bedbugs experimental survival is noted for 2-3 weeks without transmission. A number of papers on cockroaches reveal Salmonella to be present naturally and to be transmitted. Experimental findings suggest survivals from 7 days to 42 days with survival within the body and in the feces. Reports on experimental work with fleas indicate 96 hour survival in the body, less than 24 hours in the feces but transmission was possible. One report revealed natural presence with transmission. Salmonella of typhoid fever were present in flies. Experimental survival and transmission could be followed up to 23 days. One report suggested multiplication of the organism in the gut. Experimental results on survival of other Salmonella revealed persistence from 10 days up to 4 weeks. Salmonella were reported in lice. In mosquitoes survival of Salmonella experimentally was for 1 hour in one finding but with a different organism and mosquito a 3-4 week persistence is reported. In tick feces one Salmonella species survived for 35 days.

**Shigella (Table I 17) One brief report on ants suggests survival on feet for 24 hours. All other reports are on flies. Several Shigella species are reported as present with survival for 5-11 days. One report suggests multiplication of S. dysenteriae in the house fly.

**Spirochetes (Table I 18) Two papers report Treponema pertenue to be present in and transmitted by flies. One report is on experimental survival of leptospira in Triatoma.

**Vibrio (Table I 19) Reports are available on the survival of the cholera vibrio in cockroaches and flies. Persistence for 79 hours in roach feces is listed. The organism is reported as present in flies with experimental survival for 30-48 hours.

**Viruses (Table I 20) Studies are listed on bedbugs, cockroaches, flies, lice, mites, mosquitoes, reduviids and ticks.

Yellow Fever - present in bedbugs for 2 days; in mosquitoes where nature and history have shown transmission to be important, survival of 39 days in Culex with transmission, presence and transmission in Haemogogus, in Aedes survival throughout life of mosquito (approximately 200 days) is reported with the virus present in nearly all tissues. The virus was also found to survive in Triatoma for a week but without transmission. In ticks survival lasted about 6-23 days but was not transmitted by bite of tick.

Lymphocytic Choriomeningitis - Experimentally survived in bedbugs for a few minutes (10) to 85 days. It was found in cockroaches and experimentally survived in and was transmitted by mosquitoes. The same was true in ticks.

Poliomyelitis - The virus was found present, survived from 1-15 days in experimental studies in roaches with excretion for at least two weeks. In flies the virus is probably present in nature. Experiments suggested survival of 2 days to 3 weeks in different

species with possible transmission reported. Survival of 3 weeks in mosquitoes is revealed.

Coxsackie - In cockroaches experimental persistence and transmission up to 15 days is suggested.

Mouse Encephalitis - A period of 7 days for survival in roaches is given for experimental results.

Eastern Equine Encephalitis - The virus was found present in lice and mites. The mosquito is the important vector with the virus being present in numerous species of Aedes. Transmission up to 2 months was reported. The virus was also found to be experimentally transmitted by ticks.

St. Louis Encephalitis - Reports indicate its presence in mites with transmission. Aedes, Culex and Anopheles mosquitoes were found able to harbor and to transmit the virus.

Western Equine Encephalitis - This virus was found in mites. Experimental findings revealed transmission by various Aedes and Culex mosquitoes. Also reported is transmission by Triatoma.

Jap B Encephalitis - Reports of experimental transmission in Culex and Aedes showed survival from 15-91 days.

Venezuelan Equine Encephalitis - Transmission was revealed for Anopheles, Aedes and Mansonia species. Survival for 17 days was noted in Triatoma but no transmission.

Rift Valley - This virus is reported as being present in mosquitoes and of being transmitted.

Russian Spring and Summer - Ticks are able to harbor the virus for varying periods up to 40 days with transmission by Ixodes and Ornithodoros.

Dengue - The virus survived for periods up to 174-200 days in mosquitoes. Low temperatures and serial passage lowered infectivity.

Colorado Tick - This virus was found present in Dermacentor and could be transmitted.

** Headings for major groups of organisms.

THE EFFECT OF PRESSURE ON THE PERSISTENCE (SURVIVAL) OF ORGANISMS

Small amounts of pressure do not affect microorganisms particularly, but may increase the rate of some chemical reactions. If "super-pressures" in the order of 5,000 atmospheres are applied, the pressures are able to denature proteins, kill bacteria, inactivate viruses and detoxify toxins. The temperatures necessary for such activity are not raised above 20-25 C.

SUMMARY (Table P 1)

*Escherichia coli - Some 5,000 atm. of pressure destroy the cells in 45 minutes. When exposed to approximately 500 lbs/sq.in. of argon, nitrogen, nitrous oxide or carbon dioxide, some destruction of the cells occurred. Pressure at 5,000 lbs/sq.in. affected the rate of disinfection, depending upon the temperature. When 1,000 lbs/sq.in. of pressure was applied to cultures at temperatures below 37 C., growth was retarded but accelerated above 37 C.

*Aerobacter aerogenes - Very high pressures of 100,000 lbs/sq.in. destroyed in 4-5 minutes, while 50-65,000 destroyed in 10 minutes and 30-45,000 killed in 1 hour.

*Salmonella - These organisms were destroyed at 5,000 atm. of pressure in 45 minutes.

*Bacteriophage - Some strains are destroyed by 4500 atm., while others are not.

*Viruses - Rabies, herpes, yellow fever, foot and mouth, encephalitis and smallpox viruses were exposed to pressures of 3000 to 7000 atm. with resulting destruction in 30-45 minutes. Some differences in susceptibility are noted.

*Mold and Yeast - Pressures of 30-35,000 and 85,000 lb/sq.in. were tested with resulting destruction in 5 minutes-1 hour.

*Bacteria, General - Vegetative cells may withstand 6,000 atm. for 14

hours, while spores withstand 12,000 atm. for the same period. Marine bacteria may remain viable under 400-600 atm. at 30 C. for 4 days.

*Streptococcus - Exposed to 30-100,000 lbs/sq.in., these organisms survived for 4-5 minutes at the high pressures and 1 hour at the low pressures.

*Micrococcus - Some 3000 to 6000 atm. of pressure were tried on these organisms with recovery at 45 minutes with the lower pressure but not at 6000. Other experiments showed that 5000 atmospheres destroyed the organisms in 45 minutes as well.

*Mycobacterium - At 3000 atm., the cells survived 45 minutes but not with 6000atm. of pressure.

*Pasteurella - When exposed to over 2000 atm. of pressure, survival of 30 minutes was obtained.

*Serratia - At 3000 atm., the cells lived 45 minutes but not with 6000 atm. When subjected to 30-100,000 lbs/sq.in., survival of less than 1 hour was observed.

*Corynebacterium - These organisms were destroyed by pressures of 40-45,000 lbs/sq.in.

*Diplococcus - Pressures of 5,000 atm. destroyed the organisms in 45 minutes.

THE EFFECT OF RADIATION ON THE PERSISTENCE (SURVIVAL) OF ORGANISMS

Studies on radiation have shown certain ranges of the electromagnetic spectrum to be deleterious to microorganisms. This includes (1) ultraviolet (200-300 mu-or 2000-3000 Å units); (2) X-rays (0.005-1 mu); (3) γ rays (short x-rays); (4) β rays, or cathode rays or high velocity electrons; (5) α rays or high velocity helium nuclei and (6) neutrons.

It has been suggested that gamma, x-ray and UV radiation of media and organism produces toxic substances which destroy the organisms. The death rate in the organism suspensions is considered as a logarithmic one in relation to the energy absorbed. This has been shown with numerous organisms and various types of radiation. Heat is probably not the predominant factor in death of the cells.

Some reports suggest the amount of radioactive lethal doses involved necessary for killing vegetative cells and spores of different organisms at between 4-200 r x 10^3. Ultraviolet energy expended approaches 1-50 ergs x $10^3/cm^2$. Sometimes a correlation may be made between chemical sensitivity and radiation sensitivity. No exact relationships have established between sensitivity to radiation and taxonomic classification.

Several mechanisms or modes of action for radiation effects on microbial cells have been proposed. The energy must first hit and be absorbed by the cell. UV hits particularly the nucleic acids of the cell at 260 mu. The other rays hit the cell substances in general. With x-ray, gamma and beta radiation the fast moving electrons damage the cells probably by the collisions involved. Perhaps this is true of alpha and neutron radiation which also form ionization tracks through the cells.

One of the theories on radiation action is the so-called target theory whereby destruction on the logarithmic order occurs following a "hit" on the cell by radiation energy. Temperature does not affect the rate of destruction so it is assumed that no actual chemical reaction takes place in the destruction since temperature rise increases rate of chemical reaction. Areas of the so-called sensitive target of a cell have been estimated by the amount of radiation necessary to destroy the cells.

One theory suggests that a lethal mutation has taken place in the cell hit by radiation. This suggests that a particular chemical entity is changed so that life processes cannot go on. Some experiments observing cells attacked by radiation show that one or two divisions may take place and then stop--with resulting death before visible colonies can develop.

Ionizing and ultraviolet radiation may result in certain decomposition products such as quantities of formic acid or hydrogen peroxide. There is a great amount of evidence in favor of enzyme inactivation by the radiations. These inactivations or transformations in enzyme activity may result in complete inactivation of certain processes of the cell and allow others to progress resulting in the overproduction of products which pile-up and become toxic to the cells. This results in stopping of metabolism and stopping of multiplication and then in death.

In nature, the sunlight contains varying amounts of infra-red through ultraviolet radiations. The ultraviolet is especially active in the destruction of microorganisms so that cells exposed to sun rays may be destroyed much more readily than if in the dark or shaded to be protected from the sun radiation.

SUMMARY**

**-see also surfaces and soil for sunlight effects.

*Bacillus species (Table R 1) Radiation of the UV at 452 erg/m^2 at 2537 Å destroys 90% of cells. The spores and vegetative forms did not differ in susceptibility greatly. Death time ranged from 5 seconds to 30 minutes depending on exposure. Exposed to sunlight, the organisms survive for 2-6 hours on plates to 36 hours in blood. Presence of air seems to aid destruction. Ultrasonic at 320 kc destroyed cells (99%) in 45 minutes. Electrons were active in 1 second.

*Bacteria (General) (Table R 2) Some general effects of ultraviolet, sunlight, x-ray, ultrasonic and electric current are presented.

*Bacteriophage (Table R 3) Dysentery phage at 1.5 erg/m^2 per second at 2537 Å (UV) was inactivated. In sunlight phage was destroyed slowly. Ultrasonic destroyed phage in 30-60 minutes. Phage resisted radium radiations for 3 days.

*Brucella (Table R 4) Light of tropics at 44 C. destroyed cells in 45 minutes. In nature, there is a lower incidence of the disease where there is an abundance of sunlight and low humidity. Ultrasonic at 2641 kc formed rough from smooth cells in 3 hours.

*Diplococcus pneumoniae (Table R 5) These cells are reported less susceptible than some other bacteria for perhaps the capsule protects. In sunlight the organism lived in sputum for less than 5 days while in diffuse light 30 days and in the dark for 35 days. Neon light destroyed the cells.

*Coliforms (Table R 6) Much work has been done using the coliforms as an indicator of sensitivity to UV radiation. Low RH was found to increase UV action. Various ranges of the spectrum were used with most of the studies at 2537 Å where it was most active. Other strains were less resistant. Usual destruction time is in a few minutes. Rate de-

pends on UV source and distance from organisms. Organic matter protects organisms. X-ray studies suggest younger cells more susceptible. Removal of oxygen slows down killing rate. _A. aerogenes_ was reduced to 37% by 14,000 R. Ultrasonic studies reveal resistance in one report and 99.9% loss in 15 minutes in another. Coliforms have also been exposed to electrons with 10,000 volts destroying in 1 hour, and to neon with no results and to radium with no growth.

*_Micrococcus_ (Table R 7) Numerous reports of these organisms suggest that the Micrococci are quite resistant to UV. Various ranges of UV were used and different levels of energy used against several strains. Direct sunlight killed cultures at 23 F. in one hour while through glass several hours were necessary. X-rays at 3600-4400 level destroyed 63%. Ultrasonic killed 90% in 45 minutes. Low velocity electrons killed the organisms, as well as 10,000 volts, in one hour. Neon also destroys in 1 minute.

*_Microorganisms_ (Table R 8)

Alcaligenes - Two species showed wide difference in susceptibility to UV, one destroyed in 15 seconds, the other in 30 minutes.

Corynebacterium - These organisms were found more susceptible to UV than Bacillus, Staph. and others. At 55 C. in tropical sunlight, no organisms survived for 45 minutes. Cultures kept in the dark lived 1/3 to ½ longer than those exposed to light.

Hemophilus - Were very susceptible to UV.

Klebsiella - Almost completely destroyed after 3 monutes exposure to UV.

Lactobacillus - Populations of this organism were reduced by UV.

Proteus - Three minute exposure killed most cells, older cells more susceptible. Neon light was not effective in destroying them or was 10,000 volts during a 30 minute period.

Serratia - This organism was quite readily destroyed by UV. In 40 seconds to 5-15 minutes all cells killed. 10,000 volts destroyed the organism. in 1 hour.

Azotobacter - Light from sun destroys the organism in the upper layers of the soil.

Leptospira - Exposed to sun, it survived for 7 days.

Pasteurella - The plague organism was destroyed in tropical sunlight at 40 C. in 5 minutes.

Treponema - Diffuse sunlight killed the organism in 11½ hours.

*Mycobacterium tuberculosis (Table R 9) Reports reveal this organism to be more resistant than Bacillus spores. Various times are given for kill, from 3 minutes to 40 minutes. In daylight, killing is in 2-5 hours in direct sunlight and 6-8 days in diffuse light. X-ray may destroy in 64 hours. Ultrasonic at 320 kc reduces 75% in 75 min.

*Neisseria (Table R 10) UV at 2800-2540 kills. The meningococcus exposed to daylight is killed in 2 hours. When sunlight passes through gauze, 30 hour survival is obtained and 6-7 days when daylight diffuses through towelling and wool. In the dark, the organism survives 7-10 days at 25 C.

*Protozoa and Metazoa (Table R 11)

Amoeba - Short exposure to UV destroys.

Paramecium - Short exposure to UV destroys.

Necator - Exposed to light, 1 week survival is found but 5½ weeks in partial shade and 7-9 weeks in dense shade. Under varying conditions of sun and water, survival of 1 week to 6 weeks were found. In drying soil, 5, 10 and over 30 day survival was found in increasing shade. In fecal material in direct sun survival over 2 hours was observed.

*Pseudomonas (Table R 12) Variable results with UV are reported

against this organism. The flourescent strains are more resistant. In sunlight, the organisms may survive for 1½ hours at 44 C. Neon does not destroy easily. X-ray at 1000-1200 r kills 63%. Exposed to radium, the organism does not grow.

*<u>Salmonella</u> (Table R 13) UV at various wavelengths and intensities is active against Salmonella after a brief exposure. Some 214 erg/mm^2 at 2537 Å reduced population 90%. Sunlight is effective against the organisms in thin layers of water. In glass tubes, cultures may survive 1 year exposed to diffuse light. In direct sun, agar cultures are destroyed in 10-60 minutes to 4-10 hours. Neon was not effective against the organisms. X-ray did not affect in ½ hour exposure. 10,000 volts destroyed cultures in 1 hour. Radium prevented growth of the organisms.

*<u>Shigella</u> (Table R 14) UV between 2800-2540 Å killed the cells quickly. Some 168 erg/mm^2 at 2537 Å, reduced population 90%. In sunlight, these organisms were killed in less than 30-60 minutes in strong light, in diffuse light cultures in tubes lived for 75-1049 days. Ultrasonic at 680 kc and 320 kc reduced numbers 88% in 30 minutes. Neon light was not effective.

*<u>Streptococcus</u> (Table R 15) Exposed to UV, Streptococci are reduced 90% by 200 ergs/mm^2 at 2537 Å. Air irradiation destroys these as air borne infecting organisms. Some reports suggest them to be more susceptible than spores and tuberculosis organisms. Sunlight destroys the organisms in 40 minutes to 4-6 hours, diffuse sunlight may take almost 7 days while cells survive 14 days or more in the dust in the dark. Apparently larger strains are more resistant to light. Tropical sun at 49-50 C. destroys in 15-30 minutes. Neon light was effective. Organisms exposed to 10,000 volts were destroyed in 1 hour.

*Vibrio (Table R 16) UV is reported as very effective against the cholera organisms in culture and water. Sealed cultures exposed to sunlight were killed in 3 days while the cultures lived 1044 days in the dark. Diffuse light exposure allowed survival for 279 days. In sea water the organisms lived for 8 hours, exposed to the sunlight. The temperature affected recovery slightly when at 49 C. as compared to 18-30 C. Polarized light at 24 C. did not affect for 13-30 hours. Radium prevented growth of the organisms.

*Viruses (Table R 17)

Poliomyelitis - UV destroys in 30 minutes to 60 minutes usually, or shorter time, depending on distance of source. Direct sun kills within 30 minutes. Ultrasonic does not destroy rapidly but high speed electrons inactivate the virus.

Influenza - Survives UV better than many bacteria.

Vaccinia - 40 ergs at 2537 Å destroys while light plus chemicals destroys rapidly.

Herpes - Survives from less than 15 minutes to 40 minutes exposure to UV.

Encephalomyelitis - Survives only 40 minutes exposure to UV.

Tobacco Mosaic - UV inactivates this virus over a range of 3100-2652 Å.

African Horse-sickness - The virus is inactivated by UV.

Measles, chicken pox, mumps - All are susceptible to UV radiation.

Foot and Mouth - Intense sunlight exposure destroys organism in 1 hour when dried. Diffuse sunlight is resisted for over 1 hour.

*Yeasts, Molds and Fungi (Table R 18) UV radiation is effective against yeasts and molds when exposed at different wavelengths and amounts of energy. Older organisms are less resistant, in some experiments dark color of some protect against UV. Sunlight destroys in long periods

of exposure. Ultrasonic reduces population at 680 kc to 15% in 30 minutes. Electron bombardment is resisted under certain conditions but 10,000 volts destroy in 1 hour.

SURVIVAL OF ORGANISMS IN SOIL

The importance of potentially pathogenic organisms in soil has been recognized. Some of the Clostridia may cause gas gangrene or tetanus when soil gets into wounds. Some intestinal pathogens such as the organisms of typhoid and dysentery may get into the soil in excreta to contaminate foodstuffs. Certain of the protozoa and worms survive for considerable lengths of time or may live part of their life cycle in the soil entering the body through foods and sometimes through the intact skin. The organism of anthrax may survive in soil for long periods in the spore stage. Animals grazing in this area may contact the disease and die. Some areas are so contaminated that they are restricted so cattle may not graze on them. Other disease producing organisms might enter the soil from human and animal excreta or carcasses. The factors affecting the survival of many microorganisms in the soil might be grouped as to (1) soil factors (2) organism factors.

Soil Factors Affecting:

In general, the factors affecting the survival of any organism in soil would be (1) the general type or nature of the soil under study, whether sand, clay, loam or mud; (2) the amount of organic matter present or added with the organisms; (3) the amount of moisture in the soil; (4) the firmness or looseness of the soil; (5) the pH; (6) the presence or absence of antagonistic organisms; (7) the depth of the organism in the soil; (8) the temperature of the soil and air; (9) the relative humidity (RH) of the air; (10) the amount and duration of radiation from the sun.

Organism Factors Affecting:

A particular organism may survive in soil for varying periods depending up (1) the inherent resistance of the genus and species of organism under study; (2) the particular strain of organism; (3) the presence of a protective stage of the organism such as a spore; (4) the presence of a protective covering on the cell, such as a capsule; (5) the age (in the growth curve) of the inoculum; (6) the numbers of organisms inoculated and (7) the ability of the organism to multiply in the soil under the conditions presented.

SUMMARY

*Bacillus species (Table S 1) B. anthracis may survive in spore stage in soil where carcasses buried for 15-20 years. Other data suggest 12 years in surface soil and shorter periods in exposed places.

Other Bacillus species survive for over 80 days in mud and other soils and may be present in 500-600 meter deep soil.

*Brucella species (Table S 2) In sand the organisms live for about 120 days. In dirt dried rapidly it lives less than 4 days but up to 66 days in moist dirt. Viability of 1-10 weeks is reported in various soil samples. It is suggested that on pasture cover the cells do not survive long even though excreted in large numbers.

*Clostridium species (Table S 3) The organisms of tetanus, botulism and gas gangrene are fairly permanent residents of the various types of soils.

*Coliforms (Table S 4) E. coli exists in loam for weeks to months and even to 4 years if moist; if dry, only 11-25 day survival results. In sand and mud 11 week viability is reported. E. coli usually absent from virgin soil while A. aerogenes usually present. Survival of Aerobacter in soil is for many months up to almost 4 years.

*Corynebacterium diphtheriae (Table S 5) In dried sand at 37 C. viable cells were present for almost 30-50 days while in sand alone 98 to 175 day recovery was found. In soil, 98-208 day survival was found but in dried soil less than 25-35 day recovery was obtained.

*Fungi, Yeasts and Molds (Table S 6) A large part of the microbial flora is made up of Actinomyces and fungi besides the bacterial population. Actinomyces did not live well in acid peat soil. Malleomyces (not a fungus but of the Parvobacterioceae) survives in pastures up to 1 year making them unsafe. Actinomyces bovis is more or less a permanent organism in soil. Radiation from sun lowers the soil flora at

surface level. Yeasts may live in soil for long periods in winter months.

*Microorganisms (Table S 7)

Agrobacterium - In clay and loam viability over 500 days and in sand for over 600 days was reported.

Pasteurella tularensis - In muds both contaminated and uncontaminated the organism was present for 12 weeks.

Diplococcus pneumoniae - Dried culture in sand lived for 2 days and in volcanic ash for 6 days.

Vibrio comma - This organism was able to survive for 1-2 days in soil without moisture but for more than 33-68 days in moist soil. On sand 4 day to over 174 day viability is given.

Leptospira - In polluted soil 3 day survival is found. It may live for months on wet ground and high humidity in air.

Azotobacter - Large numbers in rich soil, few in acid or sunlit soils, many in dark sun-protected soil. Pure culture in soil lived for 40-85 days or more.

Pseudomonas - Survival of 45 days in soil was observed.

*Microorganisms (General) (Table S 8) Various factors of temperature, pH, fertility, moisture and radiation are presented for legume bacteria, lactic acid bacteria, nitrifying bacteria, sulfur and iron bacteria, aerobes and anaerobes.

*Mycobacterium tuberculosis (Table S 9) In soil from fecal material, the organisms may live for 2-6 months and even a year exposed to all types of weather conditions. Animals were infected from the soil in this manner.

*Protozoa and Metazoa (Table S 10)

Ascaris - On soil surfaces for 2 months to 160 days in summer, for 150-180 days in winter, are examples of soil survival. Found on vegetation where soils manured with human feces.

Necator - Survival in soil for 9-15 days is routine, some larvae live for 7-9 weeks in shade or even for 84 days. Sun, temperature and moisture affect survival.

Trichuris - In shaded soil viability for at least 35 days has been observed.

Entamoeba - Cysts may remain alive for 4-8 days in soil at room or lower temperatures. Vegetation manured with human feces was found to contain cysts.

Eimeria - Oocysts remain viable for periods of less than 1 year in soil in sun or in shade.

Sheep Nematodes - Viability of 3 months is reported in pasture soil.

Toxacara canis - The parasite remains over winter in soil under snow.

*Salmonella species (Table S 11) In dry clay 3 week survival and 6 week in wet clay was found. Similar results with loam for rainy weather survival of 120 days as compared to 49 days in plain loam. In mud survival of 5 weeks to 2 months was recorded. In peat, 1 day to 30 day recovery depending on pH, moisture and temperature were the findings. In sand, 6 day survival with sewage inoculum was observed but with sterile sand then dried, 82 day recovery was found. Variable results in soil depending on type of soil, moisture and temperature were reported with survivals ranging from a week to over 16 months. Vegetables were found contaminated from human fecal manure for at least 7 days.

*Shigella species (Table S 12) The few reports suggest survival of 12 days on sand, over 100 days at temperatures of 1-15 C. and in dry soil at 12-30 days while wet soil provided 40-90 day survival. On vegetables in soil, 7 day survival was recorded.

*Streptococcus species (Table S 13) These organisms live for periods of 26 days to 11 weeks in loam and mud. On sand, viable cells were

recovered after 33-66 days. With chicken manure on soil 160 day recovery was observed.

*<u>Viruses</u> (Table S 14)

<u>Foot and Mouth</u> - In sand at room temperatures and 50% humidity the virus survived for 14 days.

<u>Newcastle</u> - At body temperature and pH, 25 day viability was observed; at 3-6 C. 235 day survival and at -26 C. 538 day survivals were found. In chicken pen soil, 1 month viability was observed.

<u>Bacteriophage</u> - Typhoid phage was found in soil at 3 foot depth.

temperature changes; the humidity of the air will determine the rate of desiccation. Some organisms are killed rapidly by drying; others survive better in the dry state. The rate of drying is important in killing some organisms. If a surface provides protection from radiation, rain, wind and other elements then survival will be longer.

Organism Factors Affecting:

As under other circumstances there are a number of qualities in a particular organism which make it more or less resistant and allow it to survive for longer or shorter periods. The strain of organism as well as the genus and species is important since there are inherent properties of the cells which determine their ability to survive or persist in nature. The presence of a spore stage or a capsule protect certain organisms. Others apparently have resistant cell walls which protect against drying and destruction by other factors. The age of the cell at time of inoculation is important - if the cells are from old cultures, then they are more easily destroyed. Of great importance also are the numbers of cells placed on surfaces and the amount of organic matter in which the organisms are suspended. Organic matter buffers against pH and other chemical changes as well as protecting against heat, desiccation and other forces of nature. Natural secretions such as sputum and feces provide some protection to organisms.

SUMMARY

*Bacillus (Table Su 1) Bacillus anthracis because of its spore stage is able to exist for long periods. On fabrics such as canvas exposed to room temperature, low humidity and diffuse sunlight, the spores lived for 10-22½ years; enclosed in envelopes survival of over 34 years on canvas and in blood on gauze 40 year viability was reported. On glass or porcelain, survival of a few days to 2 years was found. On paper exposed to sun, 8 hour survival was found. Long survival in brushes of animal bristles was found. Other Bacillus species survived for long periods on fabrics, glass, metals and plastics.

*Brucella (Table Su 2) In dust, the Brucella lived for 20 days to 6 weeks. On fabrics such as bags and sacks, 5 days to 30 days have been observed as survival times. On glass, some survival for several days has been noted.

*Clostridium (Table Su 3) On fabrics, these sporeformers may live for at least 3½ months. Cl. tetani on glass lived for 18 years as it did also on rusty metal. Tetanus spores may exist in wounds for 6 months and in talc through autoclaving procedures. Cl. sporogenes remained viable on sutures in alcohol or toluol for over 17 days.

*Coliforms (Table Su 4) Cultures on cotton swabs survived for 8-48 hours. When dried on glass or in high humidity, survival of 22-98 days is reported. If exposed to sunlight when on glass, the cells are killed in a few minutes. On paper, survivals vary as to method of drying. Survivals on paper are given as 1 day to 143 days. Exposed to the sun, survivals of 2-10 minutes were observed. E. coli lived for 84-168 days in plaster. On utensils, coliforms are frequently found. On wood, coliforms exist for extended periods of a few days to 228 days. Coliforms also found on metal doorknobs, water filters and in grease of water pumps.

*Corynebacterium (Table Su 5) The diphtheria organism has been found in dust for a few days to 175 days. On fabrics, survival of 2 weeks to 20 weeks has been observed, with the variations due to drying procedures, the number of organisms, and the type of fabric and amount of organic material. On glass, survival of 1-2 days to over 98 days was listed. Exposed to sunlight, death occurs in 2 minutes. On paper, 6 to 159 day viability occurred but exposed to sunlight, the cells were killed in 2-10 minutes. On plaster, viability of 37 to 75 days was found and on utensils such as knives, the diphtheria organism lived for 86 days. On wood, 7-8 day persistence was reported.

*Diplococcus pneumoniae (Table Su 6) The organisms may live in dust for 2-8 days and on fabrics for extended periods of 2-13 months. On cotton swabs, cultures kept viable for 8-48 hours. On glass, the pneumococci kept alive for 2-12 months, 2 months at 80 F. and 12 months at 40 F.

*Micrococcus (Table Su 7) These organisms live for long periods on surfaces. On fabrics, such as handkerchiefs, the organisms are viable for a month or more. On glass, the cultures may remain alive when dried for from 8-10 days to 90 days at 16-18 C. When lower temperatures were studied (-195 C.), 4-15 week survival was reported. At 37 C. viability was limited to almost a week. In sunlight, the organism might survive 10-90 minutes. Organisms dried on paper survived 51-70 days under optimum conditions, but in sunlight they survived up to 71 hours. On plaster, persistence of 38 to 100 days at room temperatures was found. Organisms on rubber were easily removed. On utensils, short-term viability was reported using cleansing methods. On knives, viability of 86 days was found. Cultures inoculated on to wood samples lived 35-130 days. Micrococcus species on tinfoil were reduced readily by washing off and by UV. The organisms were found on telephones and doorknobs consistently.

*Microorganisms (Table Su 8)

Proteus - Survive in dust for 2-19 days, on moist culture swabs for 2-48 hours, on blankets for over 81 days, on paper for 11-20 days.

Rickettsia - Survives on laundry to cause infection. On paper, viability of 21 days has been recorded.

Treponema-Lives on cloth at 21-25 C. in diffuse light for 11½ hours. On glass in sun, 2 minute survival but may live in dark for several days. On paper money, 4 hour viability was shown. On dishes 2-8 day survival was found.

Vibrio - Survives on dried threads for 30 days to 7 months; the same is true on clothing. Culture swabs do not stay viable for 8 hours with few exceptions.

Pseudomonas - On glass in sunlight, 2 minute viability was found but over 7 month viability has been found on occasion.

Sarcina - When dried on glass in sun or not survival of 25-60 minutes has been found.

Bacterium linens - On filter paper survival of 90 days is reported.

Trichomonas - On an enamel paint surfaces viability of less than 7 hours was found.

Alcaligenes - Were found on telephones.

Hemophilus - On cotton culture swabs lived 8-48 hours at 16-22 C.

*Microorganisms (General) (Table Su 9)

Dust - Organisms survive in and on dust particles and are air-borne with dust.

Fabrics - Oiled fabrics contain fewer organisms, organisms may survive in towels for at least 24 hours and on blankets for 6 months.

Glass - Organisms are killed easier on smooth surfaces and than on cloth or paper or agar surfaces. Temperature increases and

humidity decreases give lower survival. Survival of 8 days to months on glass is reported. Drinking glass samples may have millions of organisms on them.

Metals - These surfaces have antibacterial and antiviral activity, especially silver and copper.

Paper - Organisms may live for long periods when dried on paper.

Wood - Various types have been tested, some allow survival longer than others.

*Mycobacterium tuberculosis (Table Su 10) Dust may contain viable organisms for days to weeks depending on amount of sun--two days in direct sun and 5 days in diffuse light have reported. Organisms have been found on fabrics (clothes and hankerchiefs) for 18-30 hours up to 39-70 days and possibly 110 days. When dried on glass, organism will live for 4 months. On paper or books live organism may live only a few hours but reports suggest over 35 days or up to 3½ months in sputum dried on books. A number of general reports show survival decreased by sunlight but survivals of 309 days listed for dark areas or 74-100 days exposed to electric light.

*Neisseria (Table Su 11) These organisms are usually low in survival rate. On fabrics, 5 minutes to 24 hour viability is shown for the gonococcus and up to 7 days for the meningococcus. On glass, a few hours of survival is usual but with dried blood up to 45 day survival has been found with the meningococcus. The g c organism lives only 2-5 hours on glass covered from the sun. On wood, dried films live for a few hours exposed to sun but unexposed the meningococcus exists for 8 days. Other studies suggest a few hours on metal and for several weeks on other surfaces.

*Pasteurella (Table Su 12) Studies of the plague organism suggest survival on fabrics is of short duration, on glass for 3 hours to

6-9 days when organic matter was present and on paper survival of 3 to 8 days with better survival at higher humidities. On filter paper the tularemia organism lived for 20 days at 20 C. in feces. On plaster the plague organism was viable for 5-11 days. On various wood samples, survival at different humidities was from 1 hour on moist pine to 36 days but survival of 2-3 months at 37 C. may be obtained and 260 days at 25 C. when unexposed to the sun.

*<u>Salmonella</u> (Table Su 13) Studies with these organisms in dust gave survivals of 20 to 130 days under varying temperature and humidity conditions. On fabrics, viability on towels was for 2 days, on cotton culture swabs for at least 1-2 days, on cotton linen and woolen cloth for 60-150 days or even longer. On glass and porcelain, survival of 2-4 days was found as minimum time but for 34-44 days when dried under optimum conditions of temperature, humidity and with protein organic material for protection. On paper, survivals of 5-10 days are given as low recovery figures with survival in fecal material on paper for 55-137 days for <u>S. typhosa</u> and 240-421 days for <u>S. paratyphi</u>. On plaster, the typhoid organism may live 83-101 days. On various wood samples at 16-18 C., viability of 9 to 119 days was reported with pine wood giving poor results and lime wood, long viability. The Salmonella have been found to survive well on bread surfaces and on metals such as iron, copper and tin for 20-30 days.

*<u>Serratia marcescens</u> (Table Su 14) This organism is used frequently as an indicator organism for air, water and surface studies because of its distinctive colony color. Studies on fabrics were made with exposure to ozone with 95% killed in 45 minutes at 21 C., 89% RH and .06 ppm. ozone. Studies on glass gave similar results. Recovery in 2 minutes was obtained in sunlight. On paper short term survival was obtained exposed to ozone and to sunlight (2-20 minutes).

*Shigella (Table Su 15) The Shiga organism was found in dust over a 10 day period. Various fabrics were studied for survival of dysentery organisms with data suggesting 4-150 days depending on temperature and light. At room temperature in the dark, 150 day survival was found, while at 37 C. only 11 day persistence was shown. The Shiga organism does not live as long on the Flexner bacillus, which is more frail than the S. sonnei. On paper, survival from 4-9 days to 270 days is recorded. Sunlight destroyed in 5 minutes. At 38 C. only ½-¼ the survival time than at 17-20 C. When dried on wood, organisms lived for 4-9 days at 17-20 C., which was 2-5 times longer than at 38 C. These organisms were able to exist for 30 hours to 2 months on bread crusts.

*Streptococcus (Table Su 16) Many studies have been carried out on streptococcus survival under natural conditions in dust, air and on surfaces. Studies on dust indicated streptococci would live 4-25 and 44 days. On fabrics, such as cotton, blankets, bedding, linen and towelling, the organisms survived for 2 days to over 4 months. Oil on bedding lowered air count and blanket counts of streptococci. Organisms on glass and dishes lived for about 14 days. When exposed to ozone a large per cent were killed on glass and paper. One report suggests 44 day viability when dried on paper. Some studies were carried out on rubber and on telephones and metal.

*Viruses (Table Su 17)

Foot and mouth - Dust allowed survival at 62 F. and 52% RH for 11 days. On glass, exposed to sun, 1 hour viability was found but when dried in dark it remained for 10 days in one case and 2 years in another. On paper, it remained active for 2 days. In nature the virus remains infective up to 345 days.

Influenza - The virus may survive in dust for at least a week and probably up to 3 weeks. On fabrics such as blankets, the

virus survives at 37 C. for less than a day but over 3 days at 22 C. If dried in saliva on blanket, viability of over 1 month has been found. Similarly, on glass, 1 week at 37 C. and over 1 month at 22 C. When dried on rubber, it remained active only 40 minutes. When dried with mucin, the virus was active for 45 days but less than 22 days in talc.

Newcastle - This virus survived over 50 days on burlap sacks at high and low temperatures, even when exposed to mercurials. At 11-36 C., 538 days of viability were observed. On glass at low temperatures, it remained active for months. On paper, the survival was similar to burlap.

Smallpox - Vesicle fluids on glass remained active in dry state for 84 days in dark and 35 days in daylight. Other reports suggest that smallpox crusts remain viable for many years.

Tobacco mosaic - On cured tobacco leaves, this virus remained active 31 years.

Swine Fever - The virus apparently was able to withstand high temperatures when on bricks or hay but was readily destroyed by chemicals.

*Yeasts, Molds and Fungi (Table Su 18) These microorganisms remain active in dust for long periods and may be carried by dust in air.

Tricophyton - The dermatophytes survived on cloth for several months and on occasion up to 346 days. On paper, viability of 102-346 days was observed.

Microsporum - On fabrics such as wool or cotton for 78-235 days and on hair for 420 days.

Molds - These microorganisms on cardboard exposed to UV lived for long periods. They are found on many surfaces and even telephone receivers.

Yeasts - They are found on various surfaces.

Fungi - Large numbers found in dust, on paper, wood and surfaces such as telephones.

SURVIVAL OF ORGANISMS IN WATER

Water has been known for a long time as a vehicle for transmission of various intestinal disease-producing organisms. Water may harbor other pathogenic or saprophytic organisms as well. It is of importance to study the effect of certain factors on the survival of organisms.

The general factors affecting survival may be listed as follows:

<u>Water Factors Affecting</u>:

The general nature of the water is important whether it is sea, lake, stream or well water, as well as the degree of pollution. The concentrations of salts will affect survival and also the organic content plays an important role. The salts may be toxic while the organic matter supplies protection as well as possible nutrients for growth. The presence of other antagonistic organisms such as bacteria, algae or phage may be important. The presence of toxic chemicals of industrial or human addition such as chlorine or sulfites affect survival adversely. The depth and turbidity of the water affect the amount of light and other radiation coming in contact with the cells. The temperature of the water affects the rate of survival as well as ability of organisms to grow. Low temperatures give longer survival. Flowing water in nature may dilute out occasional contamination.

<u>Organism Factors Affecting</u>:

The type of organism being studied is of importance in the length of survival. While the genus and species of organism is important, also the strain under study determines to a certain extent the persistence of the organism. The presence of a spore stage of the organism or a protective capsule will aid a particular organism to survive. The total number of organisms inoculated

is of great significance in length of survival as well as the age of the cell (of growth curve) when inoculated. Some organisms have the ability of growing when only a few salts are present in the water. The pathogens usually require more complex media. A few can grow on the organic matter of polluted waters depending upon the temperature. Some pathogens may grow over a range of 15-40 C. Organic matter may also protect cells from destruction even if they do not provide nutrients. Selection of resistant strains may provide greater survival of the organism under certain conditions to which they are exposed. An organism selected for resistance to increased temperature in water may not show increased resistance to some chemicals in water, but does to some chemicals.

SUMMARY

Bacillus anthracis (Table W 1) In natural water, survival is of long duration. Organisms have lasted up to 12 years in lake water, and have been found viable in rivers and stagnant pools. Under laboratory conditions, survival of 18½ years has been reported. In general, survival was better at room than at body temperature in either tap or sterile water. At low temperatures, around 10 C., survival was usually about 3 days. In distilled water, survival ranged from 30 days to 30 months. When culture medium was added and room temperature maintained survival was similar to that in natural water. Survival was reported up to 20 months in sea water. When culture medium was added, the interval was much shorter. In sewage, the organisms lasted up to 16 months.

Bacillus species (Table W 1) *Bacillus cereus* was adversely affected by pH level below 7. *Bacillus megatherium* was similar but less drastically affected. pH above 7 likewise decreased recovery.

Bacteriophage (Table W 2) The death rate of *E. coli* phage in tap water was found to be of the first order. It was extremely susceptible to irradiation while in distilled water. In sea water, a small percentage of organisms survived after 30 days. Survival in physiological saline was not as good.

Salmonella phages varied seasonally in natural waters, increasing in the summer months. In sea water they could be recovered up to 7 days after inoculation. Survival in physiological saline was not as good.

Shigella phage survived in sea water up to 30 days. This was longer than in physiological saline.

Brucella (Table W 3) *Brucella melitensis* and *Brucella suis* survived up to 10 weeks in natural waters. *Brucella abortus* in pasture water survived between 8 and 30 days. Brucella species in general were

sensitive to pH levels above 8 and below 6.6.

*<u>Clostridium</u> (Table W 4) <u>Clostridium botulinum</u> was present in ice kept at -16 C. for a month. It survived processing and heating in sewage sludge.

*<u>Escherichia coli</u> (Table W 5) In well water, <u>Escherichia coli</u> survived 2-5 months. In river water, it was found up to eighty-seven days after inoculation. Cold temperatures encouraged survival in natural waters. At 37 C., a pH of 5-6 was optimum for persistence. Radiation, natural or artificial destroyed the organisms in a few seconds. Stagnant water did not support it. One report states that after 20 years in water stored in the dark, the organism survived.

Organisms were recovered from distilled water, kept at 0-8 C. after 16 months. Increase in temperature resulted in a decreased survival rate. pH 6-8 was most favorable for survival.

Ice was found quite suitable for survival of <u>E. coli</u>. After 163 days at -20 C., organisms could be isolated. They were more resistant to freezing than to thawing.

In some cases <u>E. coli</u> could not be isolated from sea water. When organisms were inoculated they survived as long as 39 days depending on size of inoculum. Addition of culture medium lengthened the survival time.

Organisms persisted in physiological saline for over 31 months at room temperature but not as long at 37 C. At pH 8, 0.145 M NaCl allowed better survival than a greater or a smaller molarity of NaCl. Low pH or very high were unsuitable for survival at any molarity. In sewage, counts were higher in the summer. The organism could be isolated after 65 days.

*<u>Aerobacter aerogenes</u> (Table W 5) The organisms were well preserved at 18 C. in river water for up to 73 days. Lower or higher tempera-

tures were not as effective in preserving the viability. Survival was poor in raw river water. The presence of E. coli had little effect on recovery rate. Survival in sewage was similar to E. coli.

*Leptospira icterohaemorrhagiae (Table W 6) This organism survived in sterile or unsterile tap water up to a month at neutral pH. When serum was added to the water, recovery was positive at more than 3 months. When inoculated into stagnant water, at pH 7.6 and temperature 25-32 C., the organisms remained viable up to 115 days. Likewise in distilled water, persistence was fair, in sea water, poor. Sewage was more heavily infected during the warm months. Organisms survived in feces and tap water for 55 days.

*Metazoa and protozoa (Table W 7) Entamoeba histolytica survived in water at room temperature for 5 weeks. At higher temperatures, survival was poor. Ultra violet rays were quickly effective in killing the organism, sunlight more slowly so. In distilled water at 12-22 C. viability was positive after 153 days. Entamoeba coli survived even longer. In sewage, survival was from a few days to a month.

Trichomonas vaginalis survived 45 minutes. Ancylostomae species persisted from 12-18 months. In sewage sludge they survived 5 days.

Necator americanus lasted 18 months at 60 F.

Giardia intestinalis survived over 2 months in distilled water at 12-22 C. At the same temperature Chilomastix mesnili survived 187 days.

Ascaris lumbricoides eggs survived 151 days at 103 C.

Taenia saginata persisted in sewage sludge for 6 months.

Trichuris trichuria in the same medium lasted 22 days.

Paramecium did not survive well in sewage.

In general, if protozoa and bacteria were both present there tended to be an increase in protozoa, decrease in bacteria.

Micrococcus species (Table W 8) Survival of this organism in water for up to six days was usual. Addition of pus or culture medium greatly increased the survival time. Temperature range of 20-35 C. had little effect on survival. In distilled water, survival was about the same. The organism was recovered from ice after 66 days. It survived in sea water up to 36 days. In physiological salt solution, survival was not quite as good.

Miscellaneous Micro-organisms (Table W 9 & 10)

Alcaligenes fecalis was found constantly in river water. It survived 18 days in distilled water.

Corynebacterium diphtheriae survived 30 hours to 3 days in sterile water, depending on the temperature.

Neisseria gonorrheae was viable for 22 minutes in sterile tap water or sterile distilled water at 37 C. At a lower temperature survival was longer. It survived in ice 9-15 days and recovery was high in physiological saline, with culture medium added, after 6 hours.

Bacterium phosphorescens was viable after one week in fresh water.

Lactobacillus casei survived in ice and was more resistant to freezing than thawing.

Bacterium salmonicida survived up to 67 days in sewage.

Erysipelothrix was viable in sea water after 1 week and for a slightly shorter time in drinking water.

Serratia marcescens survived about 100 days in tap water, much longer in impure well water. It was susceptible to ultra-violet treatment of water. In ice there were positive cells after 51 days.

Proteus species were isolated from river water. *Proteus vulgaris* survived 103 days in ice. In physiological saline some species survived 40 days.

Pseudomonas pyocyanea flourished in all kinds of water. Survival

in distilled water was best at a low temperature. Recovery from ice was high and from physiological saline, fairly good.

Klebsiella pneumoniae survived over 31 months in distilled water. Survival was also good in saline.

*Mycobacterium species (Table W 11) Mycobacterium tuberculosis survived more than a year in tap water. Other reports on survival in natural water varied from a few days to 6½ months. In distilled water, organisms persisted after 16 months. Low temperatures appeared to promote survival. Survival in ice after 12 weeks was reported. The organisms remained viable up to 13½ months in physiological saline at 37 C. In sewage, Mycobacteria could be recovered from 1 hour to 35 days after inoculation. The lower temperature permitted longer survival. Manure kept at room temperature allowed survival up to 6½ months.

The avian strain persisted 73 days in stream water or sewage.

Mycobacterium paratuberculosis was recovered 163 days after inoculation of river water. Persistence of 9 months was also reported.

Factors Affecting Survival of Organisms in Water (Table W 12)

The effectiveness of ultraviolet radiation against water borne bacteria may be influenced by minerals in the water. Changes in salinity and osmotic pressure are better tolerated by fresh water than by marine organisms. The coliform group is not entirely reliable as an indicator of sanitation as illustrated by outbreaks of enteric disease caused by "potable" water, antagonism of some organisms against coliform cells, great resistance of some non-coliform organisms to chlorination, presence of pathogenic viruses and role of non-lactose fermenting gram negative rods in enteric disease.

In lake water, bacteria were found in greater numbers in autumn and winter. However, organisms stored in glass containers increased

more at high temperatures. Mechanical dishwashers reduced bacterial count. Sunlight was almost as effective in killing organisms on the bottom of 50 cm. of water as those on the top.

Snow, with a large dust content, carried many bacteria. Clear ice was more free of organisms than bubbly ice or snow. A great variety of bacteria have been isolated from snow.

Bacteria in sea water are more thermosensitive than are terrestrial organisms. At 40 C., 80% were killed in 10 minutes. At -16 C. organisms in sea water outlast those in distilled water or broth. The protozoa serve to rid sea water of Salmonella. When plankton are present, bacteria are virtually non-existent. The pressure bacteria experience in the sea retards terrestrial organisms. Reports were favorable as to the action of sunlight on organisms in sea water.

Bacteria in sewage, while they may survive sometimes, are subject to the action of antagonistic saprophytes. _E. coli_ is attacked by putrefactive bacteria.

*_Pasteurella_ (Table W 13) _Pasteurella tularensis_ has been reported to survive in water as long as a year. Natural waters become contaminated by infected animals. Other animals can be infected by inoculation of contaminated water.

Other Pasteurella species survive up to 4-5 hours in distilled water.

*_Rickettsia_ (Table W 14) _Coxiella burneti_ survives 7 days in water at room temperature.

Rickettsia prowazeki has been found in well water. Both tap and distilled water and also saline have an adverse affect on viability.

*_Salmonella_ (Table W 15) _Salmonella typhosa_ at outside temperature survived up to 40 days in well water. At room temperature, the survival sometimes was longer. In river water, low temperatures aided

survival. At 0 C., viable organisms were cultivated after 8 weeks, whereas at 37 C., the bacteria survived 1 week. In pond water at temperatures around 10-15 C., survivals of 4 days were reported. In tap water, storage in the dark at temperatures of 68-72 C. preserved viability for 43 days. At warmer temperatures or in the light, the cells died off more rapidly. They survived 36 days in aquarium water, up to a month in mineral water. Well water infected with urine remained positive up to 14 days. The presence of other pathogens decreased the survival time.

Salmonella typhosa survived 32 months in distilled water at room temperature. Survival rate was also high at 37 C. and at 0-8 C. In ice, the organism was viable after 7 months at 0 C. Another report found 99.9% reduction in 8 days.

Filtered sea water supported the organism for 32 days. Contaminated sea water greatly diminished the length of positive recovery interval. S. typhosa survived in physiological saline at room temperature for 32 months.

In raw sewage, the organism survived 3 days at room temperature or longer at lower temperature. In activated sludge, it was alive longer than 24 hours. Aeration of the sludge decreased this time. Lack of aeration increased it. Sterilized sewage supported the bacteria over 3 months.

Salmonella paratyphi A survived only 2 days in tap water. Boiling the water increased the survival 5 times. Filtering the water and placing it at incubator temperature increased survival interval 25 times. The organism survived 86 days in filtered rain, 42 days in distilled water at incubator temperature.

In non-contaminated sea water S. paratyphi A survived 18 days. If the waters were contaminated survival was cut to 1/3 this time.

In saline it persisted 33 days, in sterile sewage at room temperature, 7½ months.

S. paratyphi B survived 86 days in filtered rain, 42 days in boiled tap water and 22 days in unboiled tap water. Reports of survival in distilled water range from 32 days to 25 months, depending on temperature. Survival in ice was reported to be 17 days. Contaminated sea water supported the organism 12 days, sterile water up to 38 days. In physiological saline the bacteria persisted 73 days and in sewage, 24 hours to 3 weeks. Sludge activation cut the number in half in 1 hour.

Salmonella typhimurium survived in outside well water for 30 days when *E. coli* was also present. In contaminated sea water, it survived 7 days or 3 times longer in sterile sea water.

Salmonella enteritidis survived only 5 days in contaminated sea water, 23 days in non-contaminated. This organism lasted 13½ months at 37 C. in physiological saline. It was sometimes found in city sewage.

**Shigella* (Table W 16) *Shigella dysenteriae* survived in well water at outside temperature for 30 days. At room temperature, reports varied from 11-71 days. Sterile water preserved the viability from 24-30 days. Results in unsterile water were very variable. In distilled water, the organisms retained viability from 7-73 days, in ice up to 2 months, in sea water, under some conditions, 5 months and in physiological saline 13½ months.

Shigella paradysenteriae (Flexner) persisted up to 38 days in natural water and up to 73 days in distilled. In physiological saline 53 days was the longest survival time reported.

Shigella paradysenteriae (Sonne) was isolated from tap water. In well water it survived 30 days. *S. paradysenteriae spp.* survived as

long as 32 days in sea water that had been filtered and autoclaved.

*<u>Streptococcus</u> (Table W 17) <u>Streptococcus agalactiae</u> was reported to survive 66 days in natural water. <u>S. pyogenes</u> remained viable in well water for 66 days. It survived in other natural waters up to a week, in sterile distilled water up to 87 days, in physiological saline, 12 days. <u>S. faecalis</u> survived 1 hour in chlorinated swimming pool water. Under the same conditions, <u>S. salivarius</u> survived 5 minutes. In 0.85% NaCl, <u>S. mitis</u> was alive after 13½ months.

*<u>Vibrio</u> (Table W 18) Vibrio comma was reported to have survived 391 days in tap water. Other reports ranged from a few days to a few weeks. In well water it was found up to 62 days after inoculation. In raw river water, less than 2 weeks, in springs, various lengths of time, depending on the treatment of the water. Distilled water supported viability up to 29 days or sterile distilled water, 39 days. Organisms were recovered from ice up to 7 days after inoculation. The longest survival of the organism in sea water was 122 days. Others reported survivals much shorter than this. Vibrio was viable in sewage 48 hours. If the sewage was autoclaved, survival was not as good. Sterile sewage supported the organism.

*<u>Viruses</u> (Table W 19) Poliomyelitis virus survived 100 or more days in tap water at ice box or room temperature. Exposure to direct sunlight cut survival down to 45 minutes. In chlorinated lakes, the virus was killed in less than 10 minutes. In treated well water, the virus disappeared in about 1 hour.

In sewage, poliomyelitis virus survived up to 2 weeks. At 4 C. survival was even better. It was found regularly when cases were reported.

Lymphocytic choriomeningitis virus survived 3-7 days in chlorinated drinking water at room temperature.

Western equine encephalitis in the same situation, survived a maximum of 5 days and St. Louis encephalitis survived up to 4 days.

The virus of yellow fever survived 10 years in distilled water in the ice box.

*Yeasts and fungi (Table W 20) Aspergillus survived 56 days in tap or distilled water. In distilled water at room temperature, the following survived 1 year: *Cladosporium mansoni*, *Aleurisma castellanii*, *Actinomyces*, *Monilia*, *Geotrichum*, *Epidermophyton flaccosum*. In ice, Saccharomyces survived 28 weeks at pH 6.5-5, 15 weeks at pH 3.7.

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN AIR

TABLE A1 THE SURVIVAL OF BACILLUS SPECIES IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL			
B. anthracis			
Spores, dist. water, 25C. Direct sun, strong wind.	Inoc. 8,000 Colonies. Recov. 0, 2 h.	Kruse	1895
Ozone, 4 h., 37 C.	No effect	Ransome	1901
Sunlight with air	24 h.	Roux	1887
" without air.	> 83 h.	"	
Steam under pressure, autoclave, 15 lbs.	30 min.	Smyth	192[illegible]
B. subtilis			
Spores, spray drying.	Show small mortality	Bullock	194[illegible]
Air inlet temp., 180 C.	Show small "	"	
" " " 75 C.	10% killed	"	
" " " 55 C., liquid suspension, 30 sec.	50% killed	"	
Dried state, 70 C., 40 min.	"		
" " 110C., 1 h.	Comple to destruct.	"	
Moist container, 7.2%, 90C., 1 h.	Destroyed.	"	
Dust filters & precipitators effect against bacterial droplets when it is considred at the present no occupied space can be made bacteria free.		DallaValle	1944
Exposed to U.V.	Innumerable colonies 1 min., 42, 3 min.	Hart	1939
Suspended in air	62,225 (±72%) ergs/cm^2 necessary for sterilization of air.	Sharp	1940
Broth sprayed in air	2.6 bacteria/ft.^{3} air after 5 d.	Wells	1934
Dist water sprayed in air.	10 bact./10 ft.^{3} air after 7 d.	"	
Infection depends more on viability of organism than on settling rate.		"	
OUTDOOR			
B. anthracis			
Dry air, 200 F.	24 h.	Smyth	1921
B. megatherium			
Dust	Evidence of transport during storm	Soule	1934

TABLE 4 2 THE SURVIVAL OF BRUCELLA SPECIES IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL			
B. melitensis			
Dust contaminated with urine.	30 d.	Chief	1944
Dust.	44 d.	Kennedy	1905
Ozone 4 h., 22 C.	No effect	Ransome	1901
OUTDOOR			
B. melitensis			
Dry dust of Malta	20-28 d.	Horrocks	1906
Dry sterile dust	20 d.	"	
Damp sterile soil	72 d.	"	
Dry sterile manure	69 d.	"	
Moist " "	7 d.	"	
" unsterile "	20 d.	"	
B. spp.			
Incidence of infection high where total rainfall high and negligible in semi-arid areas. The sterilizing effect of continuous sunlight seems to be paramount in checking dissemination while humidity, rainfall, sunlessness & congestion of animals favors spread.		Polding	1950

TABLE 43 THE SURVIVAL OF CLOSTRIDIUM, CORYNEBACTERIUM, LACTOBACILLUS, NEISSERIA & VIBRIO SPECIES IN AIR.

Factor(s)	Survival	Reference
EXPERIMENTAL		
C. diphtheriae		
Ozone, 4 h., 37 C.	Growth resumed after 8 d. incub.	Ransome 1901
Air	2 d.	Wells 1936
C. xerose		
Maleic & phthalic anhydrides are more active than their corresponding acids. The effective vapor concentration is 25% saturation for chemical disinfection of air.		White 1944
Lactobacillus acidophilus		
Those which became suspended in the air from liquid media either by natural or artificial means settle out rapidly in 5-10 min.		DuBuy 1947
Bacterial population somewhat reduced by radiation but not consistently.		DuBuy 1948
Vibrio cholera		
Water spray, cocoon thread.	Recov. 0, $1\frac{1}{2}$ h.	Kirstein 1900
" " silk threads	Recov. 0, 72-108 h.	"
In Calcutta	Death rate increases with temperature	Ray 1950
INDOOR		
Corynebacterium diphtheriae		
Floor, dust, dark, in vitro	7-102 d.	Crosbie 1941
Floor dust sweepings.	5 wks.	"
In air after oiling floor.	Untreated, there were 7 colonies.	"
During & after sweeping	7 col. Gravis	"
" quiet period	8 ". Mitis	"
" bed making	1 " Gravis	"
Diphtheria patients	Expulsed from resp. tract by 10 of 50 patients.	Duguid 1946
Drying, R.T., 25 min.	Inoc. 204 col., Recov.0, 1h.	
" " 60 min.	" 13 " " "	Jochimsen 1928
Dust, dried, R.T.	175 d.	Ouchterlony 1949
Dust	Long periods	Pressman 1937
In talking & coughing, diphtheria patients frequently emit droplets containing viable bacilli		Teague 1913
Air	48 h.	Wells 1935
Floor dust (Gravis str.)	1 mo.	Wright 1941
Floor dust	2 mo.	"
Neisseria meningitidis		
Can be carried at night from a carrier to his neighbor unless bed space is > 5 feet.		Eagleton 1919
OUTDOOR		
Clostridium welchii		
Only sporulating forms survive when influenced by oxygen under pressure or atmospheric air conditions		Ernst 1900
Corynebacterium diphtheriae		
Air, drying.	Surv. long time in dust.	Ernst 1900
V. cholera Coldest month of year, dries out.		Rogers 1944

TABLE A4 THE SURVIVAL OF DIPLOCOCCUS SPECIES IN AIR

Factor(s)	Survival	Reference
EXPERIMENTAL		
D. pneumoniae		
Daylight, in simulated room environment	42 min.	Buchbinder 1942
Dark, simulated room environment.	12 h.	"
Spraying into atmosphere from large susp. of broth, saliva or 0.5% saline produced high mortality rate at 50% R.H. At R.H. above or below this the survival was prolonged.		Dunklin 1948
When saline free liquid used, the sharp peak in death rate at intermediate R.H. disappeared. The lethal effect of intermediate R.H. on pneumococci atomized from saliva containing suspension is increased when the particle size of the droplets is increased or when the temperature is raised. A narrow range of R.H. near 50% is rapidly lethal for organisms freshly sprayed in air.		Dunklin 1948
INDOOR		
D. pneumoniae		
Organisms susp. in fresh atomized saliva	Recov. 95.3 immed. after spraying. Recov. 329 after 75 min.	Robertson 1942
Outside body	Brief duration	Robertson 1947
22 D., R.H. 50-80%	Within 10 min. all the pneumo. had disappeared from air at 50% R.H.	" 1948
Floor dust, Types I & II	>1 mo.	Stillman 1917
Air	48 h.	Wells 1935

TABLE A 5 THE SURVIVAL OF ESCHERICHIA COLI IN THE AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL			
Air aerosols, after atomization	25 % viable	Ferry	1951
Exposed to ultra violet	Innumerable colonies at 1,3, 8 minutes	Hart	1939
Ozone, 4 hrs.	60 seconds	Ransome	1901
Air	1 day & 8 hrs.	Wells	1936
Broth & air, atomized, dark room	120 min.	Wells	1935
Ultra violet lamp off	30 min.		
Ultra violet lamp on	12 min.		
Ultra violet lamp covered	15 min.		
Increased Humidity	Increases resistance to germicidal energy	Luckiesh	1942
Susp'n in air	24,800, plus or minus 5.4% erg/cm^2 necessary for sterilizing air.	Sharp	1940
With ultra violet the bactericidal action is greatest at low humidity. In an atmosphere of 45% RH it is about 10 times as lethal as at 90% RH.		Elford	1942
Cigarette smoke has no germicidal effect & nulls germicidal activity of 10% hexyl resorcinol in propylene glycol.		Twort	1940
OUTDOORS			
Humid	Max. growth when most humid	Kopeloff	1922
Dust	4 yrs.	Savage	1903

TABLE A-6 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference
ALTITUDE		
Bacteria & mold spores.	Found at 70,000 Ft.	Armstrong 1936
Nutrient agar, 22 C., pH 7.2, 5,700 ft. above surface	103 colonies. Numerous bacteria carried along with dust into atmosphere are not killed by light, heat & dryness of desert air.	Brown 1930
Higher bacterial counts in clouds.		Dillon 1929
Lower count bacteria in clouds due to loss of electrostatic charge that caused dislodging of particles which adhered to plane		Durham 1941
Bacteria, moist film, ozone	More easily killed than when in dry state.	Alford. 1942
Bacteria sprayed into air, RH 66%, ozone, .15 ppm, 21 C., 15 min.	>99% killed	"
Ozone conc. in excess of 1 ppm. in an atmosphere of 60-80% R.H. required to produce good sterilization.		"
Ten times as many germs in [illegible] clear days as on foggy days.		LeGuyon 1931
Subnormal sunshine & precipitation deemed responsible for survival of infectious agents in air. High cooling power due to strong winds reduced resistance of people		Meissner 1940
Decreasing number of bacteria proceeding from basement to 4th floor.		Parvis 1948
Chance association with dust particles increases survival of air borne organisms.		Personnel of Navy Res. 1943
4 cases described bitten by insect native to S. America in Mojave desert.		Schlotthauer 1940
Study of # of organisms found in upper atmosphere ranging from 28 to 280		Timmon 1949
Agar plates at 19,000 to 28,000 ft. produced no organisms.		Walker 1935
EXPERIMENTAL		
Rats, G.P. & rabbits exposed to aerosol of bact. spores.	Certain areas of large spore conc. The greater the volume of tidal air, the greater the # of organisms in the lungs.	Ames 1949
Propylene glycol less efficient than phenol when applied as a paint & better than phenol when evap.		Baker 1944
A number of air borne bacteria were able to survive for a given time but decreased by raising R.H. from 40 to 60% or higher		Baker 1941
Sterilizing of air by U.V.	radiation effective when the organisms are dispersed in droplet nuclei, the smallest particles being most vulnerable	Bourdillon 1948

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference
EXPERIMENTAL, CONT.		
Air from sneezing	100,000 bacteria remain in air over 1 min. 16,000 still in air over 30 min.	Bourdillon 1942
Air with hypochlorite spray, 65 F., R.H. 66%	All or most of bacteria emitted can be killed in 3-4 min. by spray of NaHClO in conc. of 2.1 cc./1,000 cu. ft. air.	"
	Lower limit of effective humidity is below 60% at 70 F.	"
Apparatus for determination of penetration of particulate air borne material through nose described. Particles greater than 5 micra are filtered out.		Boyland 1947
In general, moving hot air is more effective in sterilizing of plane polished surface than still hot air of same temperature		Breinl 1935
Size of aggregates of micellae increased with con- concentration of saline, with increase time in sedimentation chamber.		Dautrebande 1948
Fan distribution of droplet nuclei. Disappearance of 90% in 30-60 min. Nuclei greater than 8 micra in diameter survived 20 min. Nuclei greater than 4 micra survived 90 min. Smaller nuclei survived 30 h.		Duguid 1946
Bacteria carried in handkerchief after 2 days use liberated on mild manual shaking. Recov. 14,720		Dumbell 1948
Organisms heated in presence of steam are maintained in state of intermediate hydration which makes them more susceptible to killing action of high temps. than would be the case if allowed to dry out completely.		Dunklin 1948
50% solution calcium chloride spread on floor will prevent dust 4-6 weeks.		Galambos 1942
Technic outlined for determining particle size distribution of viable air borne bacteria		Goldberg 1950
Means of sampling bacterial aerosols		" 1951
Wave length of 2537 Å highly efficient in inactivating many disease agents.		Hollaender 1946
Factors which influence efficacy of glycol vapors: 1) RH.H. 30-50% 2) Greater below 72 F. than above. 3) More effective with dirt & dust than alone.		Harburger 1945
The physiological & biological concepts for bactericidal irradiation of air have been fairly well-established by various investigators.		Hart 1944
Relatively low intensity U.V. of 2537 Å will interfere with cellular division & readily inactivate many disease agents which are not protected by other substances.		Hollaender 1942

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL, CONT.			
House dust, 30-35 C., R.H. 53-63%	Recov. 225/10 cu. ft. after 30 min.	Hollaender	1944
The bactericidal effect of glycols varies markedly with changes in temperature & in humidity, dedreasing rapidly with temperature rise & reaching maximum between 40 & 60% R.H.		Krueger	1944
Bacteria, oxygen, exposed to sunlight	3 h.	Kruse	1895
Bacteria, hydrogen, exposed to sunlight	> 7 h.	"	
Indicates that inhalation of dust borne pathogens may be important mode of spread within group.		Lemon	1948
Construction of apparatus for experimental study of respiratory infections.		Leif	1950
At a constant saturation level of glycol vapor, there was found to be approximately a two-fold increase in the rate of bactericidal action with each 15 F. increase in temperature.		Lester	1950
At high humidities the particles in equilibrium contain so much water that highly bactericidal concentration of glycol are unattainable. A limit of 290 F. should be employed in vaporizing.		Lester	1950
Equation given for determing effect of radiation on bacterial population.		Lidwell	1948
Air suspension, Low R.H.	Bactericidal effect	"	
The falling off in effectiveness at lower humidities of all bactericides considered appears to be a function of the bacteria carrying particles themselves. The maximum killing rate is attained only at vapor concentration near or in excess of sat.		"	
Vapors of most common aerial disinfectants disappears from the air at an appreciable rate by one or more of a number of processes which include aerial oxidation, dondensation upon surfaces, adsorption by surfaces. The disappearance of the vapors from the air appromated a logarythmic law over a range of concentrations.		Lidwell	1948
Lactic acid is cheap bactericide. Reached peak between 60-85% R.H.		"	
Bactericidal illumination is much slower with dust than with culture spread on slides or petri dishes at room R.H.(60%). Low intensity U.V. & fluorescent lighting of good intensity appeared to destroy the various organisms about five times as fast as natural death rate in dark.		Lidwell	1950
The treatment of cotton & woolen bed clothes and other fabrics with oil emulsion is not readily affected by changes in R.H., temperature or small variation in concentration of oil emulsion used.		Loosli	1946
Aliphatic alpha hydroxy carboxylic acids are good bactericidal agents for air disinfection.		Lovelock	1948

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL, CONT.			
One gram of propylene glycol aerosol in 2,000,000 of air effected complete sterilization of an atmosphere containing as many as 500,000 bact./l. of air.		Miller	1942
Filters prepared from gelatin permit the most successful total recovery by culture procedures from an inoculum of a known number of organisms in contaminated dust.		Mitchell	1949
Air, U.V. 20 micro watts per sq. cm. (2,537 Å)	Adequate disinfection 250-500 sec.	Mudd	1944
U.V. 30 micro watts per sq. cm. (2,537 Å)	167-334 sec.	"	
Review of methods used in preparing aerosols		Muller	1940
The two primary conditions for the successful application of U.V. for disinfection of air are: 1) the supplementary irradiation with dust suppression measures since U.V. light is not efficient against bacteria protected by dust 2) attain a radiation of sufficient intensity but not so high as to affect the eyes or skin.		National Res. Council	1947
Glycols are most effective at R.H. between 40-60% and temp. below 80F.		Niles	1946
Effectiveness of any compound as an aerial germicide depends upon the extent of condensation of its vapor on air suspended bacteria & on the rate at which the resulting conc. of germicide can produce death of the organism. At any R.H. the killing action is greater the more closely the germicide vapor concentration approaches the saturation point.		Puck	1947
Glycol vapor conc. maintained at a level just below the fogging point were found to be as effective as supersaturated atmosphere. Presence of visible mist of glycol in no way harmful.		Puck	1945
Air, 80 F. and below., R.H. 45-70%, sprayed with propylene glycol	Maximum bactericidal action.	Puck	1943
Ozone shows no remarkable effects on pathogenic bacteria		Ransome	1901
No difference of U.V. bactericidal action over a R.H. range of 35-95%.		Rentschler	1940
Temperature of organisms (within viability range) has no effect on action of U.V.		"	1941
Air borne bacteria about 1/10 as resistant to U.V. radiation as when in liquid suspension or on agar. More resistant at high R.H. than in low R.H. Lethal radiation less if bacteria first exposed to heat.		"	
Short intense dosage of bacteria with U.V. is less lethal to E. coli than long mild exposures		"	1939

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference
EXPERIMENTAL, CONT.		
Treatment of bedclothes with medicinal paraffin reduces amount of dust that can be liberated from blankets by 90%.		Van den Ende 1941
Epidemic spread of contagion depends upon deficiency of air supplied per susceptible person. The ten-fold increase in winter ventilation or its equivalent in U.V. radiation does control epidemic spread.		Wells 1943
Methods of standard bacteriologic procedure		Wells 1946
Examination at autopsy failed to reveal any difference between animals kept in glycolized air & those in ordinary room atmosphere.		Wise 1947
INDOOR		
Triethylene glycol acts as dehumidifying & germicidal agent. Introduced as vapor shows 90% reduction of bacteria in air.		Barrett 1947
Definite decrease in incidence in severity of infections of the upper part of respiratory tract noted among children kept in irradiated ward as compared with control.		Bayenberg 1940
Irradiated materials had mucm greater bactericidal action than non-irradiated material		Beckhold 1937
# of colonies diminished proportional to care taken in use of caps & masks.		Brown 1916
90-95% fewer organisms obtained from oiled blankets than from control blankets.		Dingle 1946
Gram negative bacteria in air. R.T., Combined spectrum killed most bacteria in 15-30 sec. of U.V. radiation. Preceeding freezing with liquid air makes gram negative bacteria more strongly suscept. to U.V. than gram positive spore formers.		Gartner 1947
Analysis of bacteria found in large rural central schools. 207 Strep. isolated from rooms irradiated with U.V, compared to 318 from non-irradiated rooms.		Gilcreas 1950
Marked decrease observed in total rate of incidence of upper respiratory infections following use of propylene glycol vapors.		Harris 1945
Gives various organisms detected in operating room.		Hart 1938
Bacteria have definite variations in rate of multiplication & amount of growth with changing conditions of moisture		Kopeloff 1922
Filters of air conditioner more effective when partially clogged with dirt. Neither furnace heat nor centrifuge action of blower appears to have any influence on # of organisms recirculated.		Lemon 1944
Fluorescein dispersed into air of room as powder. Recovered from dust after	20 sweepings.	Lowbury 1950
Saliva in air	36 h.	Luckiesh 194[illegible]
Organisms sprayed in air.	3000 org. /cu. ft. air. 14% of initial value, 2h.	"
37 C., textile mill	Colonies grew more than at R.T.	Matuso 1943

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference
INDOOR, CONT.		
Bacteria counts higher in Lowest in Aug. & Sept.	Jan., March, April, Dec.	Matuso 1943
If the entrance to lab. is hung with cloth soaked in carbolic acid & the window locked tightly there is considerable reduction in bacterial content of air in the room		Oesterle 1938
Bacterial content of morning air in operating room twice that of afternoon. Count is lower in the summer		Rice 1941
Use of U.V. lamps in ducts of air conditioner significantly reduced bacterial count.		Robertson 1940
Room with oiled floors had 70% reduction in air borne bacteria during maximum activity		" 1944
U.V. lamps effective in reducing bacteria & preventing spread in air ducts.		" 1939
R.T., R.H., 15-40%, glycol saturation 40-100%	2-3 min.	" 1949
The higher the concentration of glycol the more rapid the bactericidal action. Concentrations of 70-80% produced rapid killing.		" 1948
Air in nursery. No nurse in cubicle for 1 h.	9 col./10 cu. ft. air.	Rosenstern 1948
Nurse in cubicle 10 min. for diapering infant.	299 col./10 cu. ft. air.	"
No air conditioning, count aloud from 1-50 without face mask	25 col./10 cu. ft. air.	"
Air conditioning along did not prevent spread of respiratory cross infection. Germicidal irradiation of upper air together with air conditioning reduced # of respiratory cross infections. Flannel gauze mask worn by attendants of value in preventing cross infection.		Rosenstern 1948
Prevention of cross infection by U.V. & air condit.		Sauer 1942
Tabulation of 1,342 infections acquired in the laboratory. Recognized accidents in 215 instances 308 cases research, 455 cases diagnostic work, 25 cases product of biologicals, 29 cases class.		Sulkin 1951
Air before sweeping.	0.7/cu. ft.	Thomas 1941
" during "	24.1/cu. ft.	"
" after "	30 min.	"
Treatment of bed clothes with liquid paraffin causes 95% reduction in # organisms distributed in air during bedmaking.		"
Samples of air from U.V. Hospital ward averaged 5 organisms /cu. ft.		Wells 1940
U.V. irradiation checked epidemic spread of contagious diseases during cold weather, when air dry. Not effective during moist weather		" 1943
Bacterial reductions of 20-25% with use of U.V. irradiation in barracks.		Wilimon 1948

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR

Factor(s)	Survival	Reference
INDOOR, CONT.		
Rate of disappearance of bacteria from air follows logarithmic relation with respect to time. Disappearance rate increases as R.H. increases. Temp. did not effect rate of disappearance. NaOCl aerosol can effect reduction in the bacteria in the air but requires a high mist conc. The RH of air influences effectiveness of aerial bactericides. The vapor pressure of the bactericides influences its use & effectiveness as aerosol. Low R.H. more favorable t'an high for viability of air suspended organisms.		Williamson 1942
Indoor dust	3-5 million bacteria/gm.	Winslow 1912
OUTDOOR		
Strong proetolytic protein, 20 C., Incub. 7 d.	Aeration stimulates bact. growth, decomposes casein, produces ammonia, decreases nitrogen.	Allen 1940
10 to 11 mg/cu. meter of absolute humidity or greater allows organisms to survive long enough for infect.		Bey 1948
Air of sewers does not give off germs.		Jacobi 1894
Organisms in air, heavy rain.	80% reduct., 4 h.	Lewis 1907
" " light "	30% "	"
" " R.H. under 70%	214/sq. ft.	"
" " " between 70 & 80%	144/sq. ft.	"
Air windward of town.	11/sq. ft./min.	"
" leeward " "	27/sq. ft./min.	"
R.T., textile mill	Colonies from external air thrive more than at 37 C.	Matuso 1943
Effectiveness of U.V. light decreases rapidly with increasing R.H. above 55 or 60%. The rays are more efficient against small particles than large.		Perkins 1947
Samples of outdoor country air average 14.5 cu. ft. air/lactose fermenting organism. Samples of outdoor city air average 10.2/cu. ft.		Wells 1940
Street dust	49,200,000 bact./gm.	Winslow 1912
Air borne marine bacteria very resistant but killed by U.V. radiation just as readily as fresh water or terrestrial species.		Zobell 1942
Marine organisms collected on towers 30 miles inland. Terrestrial organisms collected 130 miles at sea. Collections were proportional to wind velocity.		Zobell 1936

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR (ADDENDUM)

Factor(s)	Survival	Reference	
ALTITUDE			
Can be transported almost limitless distances horizontally depending on ability to survive atmospheric environment		Jacobs	1940
Bacteria found above 19,000 ft. at -26 C. survived >48 h.		Proctor	1934
Numerous bacilli, staphylococci & micrococci found above 20 thousand feet.		"	1935
Windy weather prior to flights resulted in increased counts.		"	1942
Flights 50-60,000 meters. Bacterial distribution was Coccaceae 50.3%, Bacteriaceae 3.65%, Bacillaceae 39.8%, Actinomycetaceae 3.10 %, Spirillaceae 0.15%.		Skrsynska	1949
EXPERIMENTAL			
Erwinia amylovora			
R.H. close to 0.	Viable & infectious after 1 yr.	Rosen	1936
Hemophilus pertussis			
Air	1 h.	Wells	1936
Malleomyces mallei			
Ozone 4 h, 37 C.	Growth resumed after 8 d. incubation.	Ransome	1901
Micrococcus candidus			
Aerosols, air, after atomization.	Resistant to shock. Same vitality in aerosol as in suspension.	Ferry	1951
Proteus vulgaris			
Exposed to U.V.	61 col. 1 min.; 2 col. 3 min.	Hart	1939
Pseudomonas pyocyaneus			
Exposed to U.V.	Innum. col. 1 min.; 38 col. 3 min.	"	
Ozone 4 h.	60 sec.	Ransome	1901
Pseudomonas aeruginosa			
Suspension in air.	16,00(± 4.7%) ergs/cm^2 necessary for sterilizing air	Sharp	1940
Sprayed into air	< 1 d.	Wells	1934
Air	<1 d.	"	1936
Sarcina lutea			
Swabbed on tongue, nasal mucosa & tonsil crypts.	Usually impossible to recover.	Bloomfield	1919
Sarcina spp.			
Air, R.T., R.H. 70-72%, Triethylene glycol vaperized with hot air.	82% killed, 24 h.	Gruen	1949
Serratia marcescens			
Suspension in spray reduced to dust, R.T.	Disappeared at rate of 1.5-0.17 mm/sed. Remained floating in quiet air of room 4 h.	Flugge	1897
Water spray	Recov. 0, 27-33 h.	Kirstein	1900

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR (ADDENDUM)

Factor(s)	Survival	Reference	
EXPERIMENTAL, CONT.			
Serratia marcescens			
Ozone, 4 h.	60 sec.	Ransome	1901
Air breathed in thru nose and mouth.	Recov. 91%, 10 min. after spraying bacteria in air.		
Size of particles important:			
Large particle	87% during spraying		
Med. particle	85% 6 sec. after spray		
Small "	62%, 10 min after "	Rooks	1939
Greater recoverability of a dynamic cloud in wet than in dry atmosphere.		Rosebury	1947
U.V. light	15 min.	Rosenstern	1942
Suspension in air	20,700 (±4.7%) ergs/cm² necessary for steriliz-ing air.	Sharp	1940
Air, 29 C., sun shining	3 min. after spraying, 6,000 col.	Teague	1912
	30 min. after " 1 col.	"	
Pure cult. in nasal passage.	Shows nearly all organ-isms destroyed before reaching nasopharynx.	Thomson	1896
Sprayed into air	<1 d.	Wells	1934
Air	<1 d.	"	1936
Form & structure of organisms may be factors affect-ing persistence & viability & this may be related to infectivity.		Ferry	1951
Wave length 25 micra acts stronger against Gram neg. organisms. Chromogenic bacteria showed conspicuous stimulation at 313 micra. Spores were killed by U.V. just as fast as vegetative forms.		Gartner	1947
The rate of kill of air dried bacteria was highest at low humidity (15-20%); with rising R.H. the death rate decreased. As air-drying period increased, the rate of kill by glycol diminished. Glycol vapor was effective against particles as large as 8-10 micra in diameter but not killed as rapidly as those of 5-4 micra or less.		Robertson	1951
INDOOR			
Proteus morgani			
Dust of ward	2-12 d.	Hoare	1943
Bacteria counts in test barracks lower than control following U.V. radiation.		Jarrott	1948
At the end of the study open plates were found to be a poor method of air sampling because stray irradiation at 5 ft. level induced a 19% reduction in counts.		"	
Respiratory microbes, air, U.V., 2537 Å.	Recov. 0.5%, 2 h.	Knowles	1950
Concentration of air-borne bacteria in army barracks depended on (1) # of men present at one time (2) amount of and type of activity (3) Largest # bacteria found during greatest activity.		Lemon	1944

TABLE 46 THE SURVIVAL OF MICROORGANISMS IN AIR (ADDENDUM)

Factor(s)	Survival	Reference	
INDOOR, CONT.			
Air borne bacteria in major surgery roughly proportional to # of people present in surgery & to activity on floor proper of surgery		Nisbet	1938
Microbes in air.	Longer in humid than in dry air.	Rochaix	1931
Air, ward, during bed making	Quiet, 22/cu.ft. air. Beds in making, 510/cu. ft. air.	Rountree	1946
OUTDOOR			
Hemophilus influenza — Death rate high during 4 mo. period of high R.H.		Barreto	1948

TABLE 42 THE SURVIVAL OF MYCOBACTERIUM TUBERCULOSIS IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL			
Water droplets carry microbes. G.P. not infected after inhaling dry tubercle bacilli for 1 h., but infected in few seconds inhaling humid ones. Rain does not play important pathogenic role. Fog does play pathogenic role		Aimes	1933
Droplets on plate, 45 C., 20-38 cm. from speaking or coughing persons mouth.	300-600 times increase in count.	Flugge	1921
Loud speaking	40-1,000 Times increase in 30 min.	"	
Drops from bronchial tree in 20 coughs.	100-8,000 times inc.	"	
Sputum of tuberculous patient.	50,000 bacilli/mg.	"	
Tubercle bacilli dan be recovered from macroscopically normal lung tissue of rabbits several weeks after primary infection		Heppleston	1949
When radiant energy of low intensity, it redudes the incidence of T.B.		Lurie	1944
U.V. of 2537 Angstroms exercised protective influence against natural air borne contagion.		"	
Ozone, 37 C., 4 h.	No effect	Ransome	1901
Use of saline solution in the Wells centrifuge will not permit collection of tubercle bacilli in atmosphere. Because of size, the bacilli fall out of atmosphere rapidly. When expelled from mouth they are enclosed in albuminous material which tends to stick to whatever it contacts.		Sim	1939
INDOOR			
Dust in air of rooms of tuberculous persons, R.T.	1 of 50 G.P. inoc. with dust died with T.B.	Augustine	1929
Surface dust from rooms of tuberculous families, R.T.	Found in dust six of 24 observations.	"	
Dust from clothing of tuberculous families, R.T.	10 of 62 inoc. G.P. died of T.B.	"	
Washings from childrens hands, R.T.	No results	"	
Open pulmmonary tuberculous patient.	Expulsed from resp. tract by 10 out of 20 patients.	Duguid	1946
0.5-0.1 mg. cult./cc water sprayed in G.P. vicinity	Bacilli in bronchi 1-72 h. Negative 144 h.	Heymann	1908
Dust	8-14 d.	Kirstein	1905
Sputum droplets	4-7 d.	"	
Hypochlorite & quaternary ammonium compounds.	Weak tuberculocidal effect	Klarmann	1951
More emphasis than usual should be laid upon measures to prevent contamination of air. Specific experimentation has proved that U.V. has marked favorable effect.		Long	1951

TABEE 17 THE SURVIVAL OF MYCOBACTERIUM TUBERCULOSIS IN AIR

Factor(s)	Survival	Reference	
INDOOR (CONT)			
The use of glycols as vapors is suggested for killing tubercle bacilli in closed spaces.		Potter	1944
Dust	Long periods	Pressman	1937
Aspiration of 1.4 cu. ft. air/min. not efficient for air sampling for isolation of T.B.		"	
Sputum in air shaft	45 d.	Ransom	1905
Dust of T.B. wards.	Can withstand drying	Rogers	1920
Sputum of floor	2-2½ mos.	Sawizky	1891
Dust, room, hospital & home	Long periods	Thomas	1941
OUTDOOR			
Dust, sunlight, dry	72 h.	Caldwell	1925
Mixed with sterile dust, direct sun rays	5 h.	Sweany	1919
Inhalation of a few tubercle bacilli in the nuclei of droplets coughed or sneezed into atmosphere is of greater consequence than from larger number of organisms in coarse particles which are strained out in the upper resp. passage & ingested.		Wells	1948

TABLE 48 THE SURVIVAL OF PASTEURELLA SPECIES IN THE AIR

Factor(s)	Survival	Reference	
GENERAL			
P. pestis			
Dust	Dries rapidly	Eskey	1938
P. tularense			
Streams & grain in Russia	Rats and mice are vectors	Maximow	1947
Tularemia infection acquired by inhalation of dust from threshing mills contaminated by infected rodents		Ayres	1948

TABLE: A 9 THE SURVIVAL OF PROTOZOA, METAZOA, BACTERIOPHAGE AND RICKETTSSIAE SPECIES IN AIR.

Factor(s)	Survival	Reference	
EXPERIMENTAL			
Bacteriophage			
Transmitted through air with droplets & dust in manner entirely analogous to transmission of bacteria		Colvin	1932
Colloids protect bacteriophage against drying both in vacuo or in air.		Kriss	1948
Rickettssiae spp.			
Dyer Nine Mile, Henzerling str. % saline susp. yolk sac.	30 min.	Ransom	1951
INDOOR			
Rickettssiae, typhus			
May be transmitted by air.		Loffler	1942
OUTDOOR			
Entamoeba histolytica, cystic			
Air dried	Recov. 0	Kuenen	1913
C. burneti			
Air of goatery	Known infection in herd contaminates air considerably.	Lennette	1951

TABLE A/0 THE SURVIVAL OF SALMONELLA SPECIES IN THE AIR.

Factor(s)	Survival	Reference	
EXPERIMENTAL			
S. typhosa			
Paper slips in vapor of 35 gms. phenol/1000cu. ft.	Recov. 0, 1 hr.	DeOme	1944
Water spray	Recov. 0, 27-30 hr.	Kirstein	1900
Ozone, 4 hrs.	60 seconds	Ransome	1901
Ozone, 4 hrs, 22 C.	No effect		
Air	8-24 hrs.	Wells	1936
S. dysenteriae (Hiss Y)			
Air	8-24 hrs.	Wells	1936
S. paratyphosa			
Air	8-24 hrs.	Wells	1936
S. pullorum			
Increasing RH from 15-80% increases death rate. Given RH with increase from 28-37 C Death rate increased. The combined effect of increased temp. & RH appears to be cumulative.		DeOme	1944
INDOOR			
S. pullorum			
Air, 28 C, RH 15%	50% death, 27.5sec.	DeOme	1944
Air, 28 C, RH 46%	50% death, approx. 7 seconds.		
Air, 37 C, RH 42%	50% death, 5 sec.		
When dispersed from broth into dust-free air its death rate was greatly decreased indicating that certain materials dispersed with bacteria may have a marked protective action		"	"
OUTDOOR			
S. typhosa			
Direct rays of sun	4-10 hrs.	Osler	1901
S. enteriditis			
Open air, broth plate	Recov. on 5 occasions.	Hewlwtt	1905

TABLE A 11 THE SURVIVAL OF STAPHYLOCOCCUS SPECIES IN AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL			
S. albus			
0.2 mg/l. of propylene glycol, R.H. 41% : Immed. after spraying	Control, 9750 col., 1 cu. ft. test.		
15 min. after spraying	Control 9360, 1 cubic. ft.		
30 min. " "	" 9260, " "		
60 " " "	" 3220, " "	Bigg	1944
Sprayed into air, R.H. 50%	Lethal for organisms.		
R.H. on either side of "	Prolongs survival	Dunklin	1948
Sprayed in aerosol. Safe in R.H. 160-90% exerted	ozone conc. (0.04 ppm) disinfectant action	Elford	1942
Exposed to U.V.	66 colonies 1 min., 2 col. 3 min.	Hart	1939
U.V. LIGHT	26,200 ergs/sq.cm. sufficient to kill all suspended bacteria present with exposure of 1.06 sec.	Sharp	1938
Suspended in air	23,300 (±5.1%) ergs/cm^2 necessary for steril. air.	Sharp	1940
S. aureus			
Dried in nasal secretion in handkerchief.	Lg. # surv. > 1 mo.	Duguid	1948
Suspended in air	26,500 (±5.7%) ergs/cm^2 necessary for sterilizing air.	Sharp	1940
Sprayed into air	3 d.	Wells	1934
S. citreus			
Exposed to U.V.	102 col., 1 min, 6 col. 3 min.	Hart	1939
S. pyogenes			
Greater numbers released in dust than by sneezing. 50% reduction when wearing surgical gown.		Duguid	1948
S. spp.			
Killed rapidly at 70-90% R.H. with sprayed HClO. Bactericidal effect reduced in atmosphere of extremely low carbon dioxide content (0.001%) compared with behavior in N_2. Organisms in finely dispersed mixture killed more rapidly than those in heterogenously sprayed particles.		Elford	1945
Wounds cross infected	18 of 28 surgical wounds.	Rountree	1947
INDOOR			
S. albus			
Air during & after cleaning.	Found in air during 1st & 2nd hours.	Furtherer	1946
Dried on glass, 15-16 C., R.H. 15-60%, Exp. to Exposed to ozone for 5, 6 & 9 hrs.	No killing or inhibition of bacteria.	Galli-valerio	1914

TABLE A11 THE SURVIVAL OF STAPHYLOCOCCUS SPECIES IN AIR

Factor(s)	Survival	Reference	
INDOOR (CONT.)			
S. aureus			
Air during & after cleaning	Found in air during 1st & 2nd hrs.	Furtherer	1946
Most of infections from air contaminated by operating room personnel & patient.		Hart	1937
Floor dust	Several days.	Lidwell	1950
Survives better at low than at high R.H.		"	
Air of operating room	Survived in U.V. light.	Phelps	1939
S. spp.			
R.H. 5-80%	Maximum humidity effect between 60 & 70%	Robertson	194[illegible]
OUTDOOR			
S. aureus			
Conc. calcium chloride, R.H. 35-48%	Least growth with minimum humidity.	Kopeloff	1922

TABLE A12 THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE AIR

Factor(s)	Survival	Reference	
ALTITUDE			
S. spp.			
Sprayed with 5 ml. of 1% hypochlorite sol'n.	95% killed; 5% recov.	Andrews	1940
Oiled blanket, plates exposed 5 min. during and after beating	170 colonies		
Unoiled blanket, plates exposed 5 min. during and after beating	1030 colonies	"	"
EXPERIMENTAL			
S. pyogenes (Group A)			
Exposed to daylight in simulated room envirn.	252 min.	Buchbinder	1942
Dark, simulated room envirn.	65 hrs.	"	"
Sprayed in air, settle on filter paper, daylight.	6 hrs.	Buchbinder	1941
S. pyogenes (Group B)			
Exposed to daylight in simulated room envirn.	66 min.	Buchbinder	1942
Dark, simulated room envirn.	132 hrs.		
Sheep blood agar, 18 hrs, 37C., dark room, susp'n in air.	Remain viable in dust of room at least 2 wks.; some impairment of virulence	Buchbinder	1941
Exposed to ultra-violet, 1 min.	98 colonies	Hart	1939
3 min.	12 colonies		
Air and triethylene glycol, CO_2, 70F., RH 40%	10-15 min.	Wise	1949
Bactericidal effect of irradiation of beta strep. appeared to depend on both RH and the susp'n med. Organisms in films prepared from serum broth cult. containing dust behaved like those of dust and were more resistant under dry conditions. Org. in films from extracts of dust or from serum broth culture were more sensitive under dry condit.		"	"
S. pyogenes (Group C)			
Sprayed into air, RH 50%,	Rapidly lethal	Dunklin	1948
Sprayed into air, RH above or below 50%	Increases survival	"	"
Propylene glycol vapor conc. 0.2mg/l, RH 42%, 1 cu. ft. immediately after spraying,	4166 colonies	Bigg	1944
15 min. after spraying	3120 "		
30 min. after spraying	1760 "		
60 min. " "	442 "	"	"
Sprayed in aerosol. Ozone in safely tolerated conc (0.04ppm) in RH of 160-90% exerted a disinfectant action.		Elford	1942

TABLE A/2 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE AIR

Factor(s)	Survival	Reference	
EXPERIMENTAL(cont'd)			
S. pyogenes(Group C)			
Infections mainly due to particles smaller than 1.8u in diameter. As bacteria median diameter increases from 1-12u the aerosol dose had to be increased 10,000 times to kill 50% of animals. Pulmonary infection occurred much more readily than URI.		Sonkin	1951
S. pyogenes			
Sprayed into air	Rapidly killed in dry atmos., but protected in moist.	Wells	1942
RH 40-70%	Disinfection most apparent here.	"	"
Sprayed into air	Many float for many hrs. after all droplets have evaporated.	Buchbinder	1938
Exposed to room environ.	No evidence that property of any strains were adversely affected	Buchbinder	1941
Oiling blankets, bed linen, garments, and floors reduced bacteria and hemolytic strept. of air during bed making to 91-98% below control ward		Cruickshank	1947
S. viridans			
Exposed to daylight in simulated room environ.	44 min.	Buchbinder	1942
Dark, simulated room environ.	26 hrs.		
Sprayed in air, settled on filter paper, sunlight	50%, 5 min.	Buchbinder	1941
In dark and sunlight	Survival ranged from 14-93%	"	"
Wounds	3 of 82 surgical wound	Rountree	1947
S.salivarius			
Sprayed in aerosol. Ozone in safely tolerated conc (0.04ppm.) in RH of 160-90% exerted a disinfectant reaction.		Elford	1942
S. zooepidemicus			
Atomization reduced chain length by 50%. Recov. of viable organisms decreased with distance from atomizing nozzles when conc. cell susp'n used no. of mo. required to infect was larger by airborne route than by direct nasal route.		Shechmeister	1950
S. spp.			
70-90% RH, HC10 spray	Killed rapidly	Elford	1945
Irradiation classrooms	207 colonies	Gilcreas	1950
Non-irradiation of classrooms	318 colonies		
Strep. susp'n in air remain viable a t least 2 wks in dust of room with some impairment of virulence		Buchbinder	1941

TABLE 412 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE AIR

Factor(s)	Survival	Reference
INDOORS		
S. pyogenes		
Blankets, ENT ward	14,400-7,344,000/cu. ft. of air	Rountree 1946
Use of oil, water, and Roccal emulsion	Reduced no. in air 33-63%	Shechmeister 1947
Air	48 hrs.	Wells 1935
Dust	25 das.	White 1936
Floor dust	67% of 185 samples	Williams 1949
Air from patient with cellulitis, PM.	3 recovered	Willits 1941
AM.	40 "	
while making bed	6 "	
while making bed briskly	14 "	
Room air, scarlet fever ward, blood agar plates, exposed to air 3 hrs.		
AM.	334 colonies	Allison 1937
Afternoon	228 colonies	
PM.	19 colonies	
Air in infant ward	Total counts for air in UV wards consistently lower than control ward	Brooks 1942
Air in scarlet fever ward	Absent at night, rise in AM, slowly falls in PM	Brown 1937
Found in congregation in cities	------	Buchbinder 1938
Dust	Several weeks	Cruickshank 1938
Oiled beds	26 of 307 cult. positive	Dingle 1946
Unoiled beds	160 of 441 ", positive	
Droplets from cough	39 of 87 pts. were throat carriers	Duguid 1946
Hospital dust, air settled on filter paper in Petri dish, dark	65 hrs.	Garrod 1944
sunlight	4 hrs.	
Hospital floor dust, R.T., dark	195 das.	
diffuse sunlight	Bactericidal	" "
Air in dormitory	0.22 inf. particles/cu.	Green 1945
Air in movie	0.33 inf.particles/cu ft	
Air in school room	0.63 " " "	
Air in recreation room	0.38 " " "	
Infections appreciable only when premises occupied Diminished to low level very quickly after vacation.		" "
Information relative to occurence in air of hosp.		Hamburger 1944
Nasal carriers desperse 80-100 times as many strep as do throat carriers alone.		Robertson 1947
Some influence of humidity on death rate as in pneumococci(10), but effect less pronounced		Robertson 1948

TABLE 11/2 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE AIR

Factor(s)	Survival	Reference	
INDOORS(cont'd)			
S. pyogenes			
Talking	-----------	Robertson	1948
Relative dry air, saliva suspended, triethylene glycol vapor	Highly susceptible after 5 hrs. desiccation	Robertson	1951
Air, low RH, saliva, suspended in air, triethylene glycol vapor	Slower rate of kill after desiccating 20 h		
Droplets from coughing	Practically none expelled.	Robertson	1948
Blankets	>4 mos.	Robertson	1947
Floor dust	Several das.	Lidwell	1950
Army barracks, air. Contamination high in spring, low in winter and summer. Bedding of persons with positive culture showed higher count. Highest counts obtained during max. activity.		Loosli	1948
Air and dust in hospital wards	From w ar wound infections	Miles	1940
Air in barracks during heavy activity	40/10 cu. ft. of air	Miller	1948
Air in barracks during moderate activity	2/10 cu. ft. of air		
On floor, petri dish, dark	20% alive, 14 das.	Phelps	1939
diffuse light	<1% alive, <7 das		
Sprayed culture	Practically all settled in 48 hrs.		
Air, single noseblow by carriers.	Millions recovered	Hamburger	1946
Air, coughing by carriers.	Relatively few recov.		
Sneezing by carriers	Very few recovered.		
Triethylene glycol, RH 40-50%, bed making	88.6-54% reduction	Hamburger	1945
Air, hospital wards, glycol vapor	Diminution of bacteria of 32-75% during periods of glycolization	Hamburger	1945
Air after shaking cloth	Persisted over 15 min.	Duguid	1948
S. pyogenes (Group C)			
Ultra violet	In low conc. of air, UV markedly reduced bacteria	Henle	1942
Freshly atomized	Not killed as fast as those in low humidity. floating for 5 hrs.	Robertson	1951
RH 15-20%, floating in in air for 5 hrs.	Killed twice as fast as those exposed after atomization		

TABLE 4/2 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE AIR

Factor(s)	Survival	Reference	
INDOORS(cont'd)			
S. pyogenes (Group A)			
Bedding and floor dust	4 das	Lemon	1944
Air	378/ cu. ft.		
Air, droplet nuclei expelled by sneezing	50%, 20 min.	Robertson	1948
S. salivarius			
Vapors of lactic acid, mandelic acid & triethanolamine, RH 70%, 15-21 C.	Gave good kills of org in sprayed saliva	Lovelock	1944
S. spp.			
Air, dust, R.T.	2 wks.	Phelps	1941
Dust	Long periods	Pressman	1937
Blankets and air	Many months	Robertson	1944
Glycol vapor	Caused 70% reduction in bacteria		
Room, floor & blankets treated with triethylene glycol	90% reduction	"	"
Survive better at low than at high RH.		Lidwell	1950
Dust, oiled linens and floors	Survive 19 wks. 92.3% reduction during bed making. 79.1% reduct. during sweeping.	Bigg	1947
Ist hour after cleaning	Found in air; not found after 2 hrs.	Furtherer	1946
Air drying	Many mos.	Ernst	1900
OUTDOORS			
S. pyogenes			
Air after shaking clothes	Persisted over 15 min.	Duguid	1948
S. spp.			
Air, drying	Many mos.	Ernst	1900

TABLE A 13 THE SURVIVAL OF VIRUSES IN AIR

Factor(s)	Survival	Reference	
ALTITUDE			
Numerous viruses are carried along with dust into the atmosphere, many of which are not killed by light or heat.		Lange	1927
EXPERIMENTAL			
Influenza			
Vapors of lactic acid	Sterilized nebulized allantoic fluid infused with influenza	Catalano	1948
Moisture, stagnating moist air, ammonia, & other alkaline substances in the air increase incidence of grippe. Presence of acid substances in the air and dry clear weather counter-act grippe epidemics.		Cauer	1949
Dust, drying	Inoc. 1 X 10^4 after dry. Recov. 0, 3 wks.	Edwards	1941
Air of experimental tank	1 h.	"	1943
Aerosol over water (PR8)	Reduction in infectivity 90%, 30 min; 99%, 1 h. 100%, 3 h.	"	
Influenza virus dispersed in air is killed more quickly in humid than in dry air. Exposure to bright daylight increases the rate at which sprayed organisms die off in air.		"	
56-57C. for 30-45 min.	Necessary for inactivat.	Hirst	1943
Atomized suspension, R.H. 50%	Death of 22.5% exposed mice	Lester	1948
Atomized suspension, R.H. 30-80%	Death of 100% exposed mice.	"	
Atomized, dialysed susp. R.H. 50%	Death of all " mice.	"	
27-29 C., R.H. 80-90%	Infectivity time 1 h.	Loosli	1943
" " 45-55%	" " 6 h.	"	
" " 17-24%	" " 24 h.	"	
Dust dried in floor sweepings. (PR8)	22 h.	"	
Vaccinia			
Chorio-allantoic memb. chick, sprayed in air	8 hrs. More susceptible to room environ. than strep.	Buchbinder	1941
Virus retained virulence in all gases for 3 wks. when kept at 4 C. Became avirulent at 37 C. Pure oxygen or carbon dioxide gas destroyed virus at 18 C.		Noguchi	1918
Susceptibility of virus to irradiation is of same order as bacteria		Rivers	1928
INDOOR			
Influenza,			
Sterile blanket	Survives drying	Krueger	1942

TABLE A/3 THE SURVIVAL OF VIRUSES IN AIR

Factor(s)	Survival	Reference
INDOOR, CONT.		
Influenza		
Dispersed into air (A)	Killed more swiftly in humid than in dry air.	Loosli 1943
Dust	Long periods	Pulvertaft 1947
Mice exposed 20 min. (PR8)	Recov. in 0 mice, 20 min.	Robertson 1942
Air	Infected mice after 3 h.	Robertson 1943
Dust	Survived for days	"
Air, R.H. 80-90%, 1cc. triethylene glycol vapor.	<1 h.	" 1944
Air, R.H. 25-30%, 1cc. triethylene glycol vapor.	36 h.	"
Air, dry, after shaking canvas floor covering	6 d.	"
Air	Many days.	"
Lab. conditions, 1 cc. vaporized triethylene glycol.	Highly lethal	" 1949
R.T., R.H. 15-40%, vapor of triethylene glycol saturation 40-100%	Killed in 2-3 min.	"
R.T., R.H. 15-40%, vapor saturation of glycol 70-90%	Exposed mice completely protected against lethal concentration of virus.	"
Salt free virus atomized into an atmosphere of R.H. 50%. All mice died indicating that lethal effect of 50% humidity had been abolished by removal of salt.		Robertson 1948
Air, sprayed with glycol	40-60 min.	" 1943
Dispersed into air, R.H. 20-30%, Mice exposed.	22% died at R.H. 45-60% Death rate inc. to 80% R.H. when all mice died.	Robertson 1948
Type A. The % recovery of the virus aerosol was independent of initial concentration of atomized suspension. High aerosol recovery obtained in extreme ranges of 32-68% R.H.; minimum recovery 60% R.H. The mean diameter of influenza virus aerosol was <0.5 micra. Characterized by greater infectivity when introduced by air borne methods rather than intra-nasal routes.		Shechmeister 1950
R.H. 32-65% (A)	High aerosol recovery	"
" 60%	Minimum " "	"
OUTDOOR		
Foot & mouth		
Normal atmospheric cond.	1 wk.	Burbury 1928
Related epidemiologically to distribution in dust.		Ostertag 1943

TABLE 4/13 THE SURVIVAL OF VIRUSES IN AIR

Factor(s)	Survival	Reference
OUTDOOR, CONT.		
<u>Infectious jaundice</u>		
Dust borne dried excreta carries causative organisms. Less common in towns than rural districts.		Anderson 1947
<u>Influenza</u>		
Mucin in air (Type A)	Recov 0, 15 h.	Parker 1944
Air current	Recov. 2, 72 h.	"
Dried with talc in air.	" 0, 22 d.	"
R.H. 80-90%, 1cc. glycol vapor	< 24 h.	Post 1945
Dry	36 h.	"
<u>Smallpox</u>		
Epidemic in India		
Humidity rise	Lower incidence of disease	
Low absolute humidity favors disease.		Rogers 1928
R.H. low absolute	Seasonal rises in incidence	" 1948
GENERAL		
Air borne viruses killed as easily as Strep. salivarius by HClO mists.		Edwards 1943
Animal viruses have sensitivity similar to bacteria at wave length of 2537 Å.		Hollaender 1943
Means of obtaining infections in lab: 1) by use of Waring blendor 2) Opening sealed glass ampoule. 3) Inhalation of infectious material 4) Inadequate disposal of contaminated material. 5) Inadequate handling of autopsy material		Smadel 1951

TABLE 4/12 THE SURVIVAL OF YEASTS, MOLDS & FUNGI IN AIR

Factor(s)	Survival	Reference
ALTITUDE		
Alternaria		
Air	Found up to 16,000 ft.	Stakman 1923
Black stem rust spores		
Viable up to 10,000 ft.	in the air.	Cotter 1931
Cronertium ribicula		
Air	Found 110 miles beyond limit of pines	Pennington 1925
Aeciospores in air	Carried 300-400 miles in Pacific coast region.	Lachmund 1941
Fungi imperfecti		
Air	Found at 36,000 ft.	Rogers 1936
Gymnosporangium		
Air	Viable basidiospores found up to 2,000 ft. Good % viable sev. d.	MacLachlan 1935
Molds		
Found above 19,600 ft.	in the air	Proctor 1934
Pestalazzia		
Air	Viable spores at 18,000 ft. over Washington, D.C.	Meier 1933
Phaeocrytopus gaumanni		
Spores	Blown across North Sea from England to Denmark.	Buchwald 1939
Puccinia graminis		
Spores	Blown from south into Dakota & Minn. in 2 d.	Lambert 1929
Spores collected at 10,000 & 16,500 ft. in Southern U.S. in spring.		Proctor 1942
Tritici carried 50-250 Kilometers over sea without losing viability.		Roussakov 1926
Air, blown from South to	Dakotas & Minn. in 2 d.	Stakman 1934
Ragweed pollen		
Air during flights.	Greatest conc. pollen at 3500 ft.	Heise 1948
Rust		
Spores	From height of 5,000 ft. in 30 mi. wind may travel up to 1,200 mi.	Proctor 1942
Spores	3 mi. high	Stakman 1923
Sclerospora philippinensis		
Air	Viable spores travelled 8-80 ft.	Weston 1923
Uredeospores		
Found viable up to 5,000 ft. at Norway House, Manitoba which was assumed that they had been carried horizontally for at least 200 mi.		Bailey 1928
Of leaf & stem rust.	Found up to 10,000 Ft.	Stakman 1923
General		
The influence of winds aloft on the concentration of solid particles is of minor importance compared to lapse rate.		Heise 1949

TABLE 4/2—THE SURVIVAL OF YEASTS, MOLDS, & FUNGI IN AIR

Factor(s)	Survival	Reference
ALTITUDE		
General, cont.		
Four species isolated from Antartica where mean temp. is -20 C.		McLean 1918
EXPERIMENTAL		
Aspergillus		
Exposed to U.V.	10 min. innum. col., 20 min., 0 col.	Hart 1939
Geotrichum		
Exposed to U.V.	3 min., innum. col., 10 min., 0 col.	"
Monilia		
Exposed to U.V.	1 min., 200 col., 5 min., 0 col.	"
Mucor		
Exposed to U.V.	1 min., innum. col., 5 min. 25, 10 min., 0 col.	"
Penicillium		
Exposed to U.V.	10 min., innum. col., 20 min., 0 col.	"
Pink yeast		
Water spray	Viable 10-14 d.	Kirstein 1902
Saccharomyces albicans		
Ozone, 4 h.	60 sec.	Ransome 1901
INDOOR		
Fungi paralleled bacteria except more abundant in textile room with high R.H.		Matuse 1935
OUTDOOR		
Coccidioides		
Chlamydospores in dust.	Easily transported in air.	Dickson 1938
Infection rates highest in dry seasons & dusty conditions. Rate of infection diminished by dust control. Southern climates have highest inf. rate.		Smith 1946
Molds		
Spores in sea air	Long periods of time	Zobell 1942
Puccinia malvaccarum		
Moist atmosphere, 1 C.	50 d.	Cohen 1946
Phytomonas malvacera		
Wind-blown rain	Important factor in dissemination	Faulwetter 1917
Sporotrichosis		
15-20 C., High R.H., abundant rainfall	These conditions must exist several days for contraction of disease.	Mackinnon 1949

References (Air)

1. Allison, V.D., and Brown, W.A. 1937 Infection of the air of scarlet-fever wards with Streptococcus pyogenes. J. Hyg., 37, 1-13.
2. Ames, A., and Nungester, W. 1949 The initial distribution of air-borne bacteria in the host. J. Infectious Diseases, 84, 56-63.
3. Anderson, I.S. 1947 Infective jaundice in Iceland. Lancet, 252, 778-781.
4. Andrewes, C.H. 1940 Control of air-borne infection in air-raid shelters and elsewhere. Lancet, 2, 770.
5. Armstrong, H.G. 1936 The medical aspects of the National Geographic Society-U.S. Army Air Corps Stratosphere Expedition of November 11, 1935. J. Aviation Med., 7, 55-62.
6. Arthur, D. 1894 Bacteriology of sewer air. Sanit. Record, London, 16, 1160-1162.
7. Augustine, A.E. 1929 The transfer of tuberculosis by dust and other agents. J. Prevent. Med., 3, 121-138.
8. Bailey, D.L. 1928 Studies in cereal diseases. IV. Stem rust in western Canada. Dom. Can. Dept. Agr. Bull.
9. Baker, A.H., and Twort, C.C. 1941 The effect of humidity of air on the disinfection capacity of mechanically atomized and heat-volatilized germicidal aerosols. J. Hyg., 41, 117-130.
10. Barreto, Joao de Barros 1948 Temperature, humidity and rainfall in relation to respiratory diseases in Brazilian cities. Mem. Inst. Oswaldo Cruz, 46, 199-232.
11. Bigg, E. 1943 Effect of propylene glycol on bacterial spores. Proc. Soc. Exp. Biol. Med., 53, 120-121.
12. Bigg, E., Jennings, B.H., Fried, S. 1944 Use of glycol vapors for bacterial control in large spaces. Am. J. Med. Sci., 207, 361-369.
13. Bigg, E., and Olson, F.C.W. 1946 Experience with the practical application of triethylene glycol vapor for the control of air-borne infection. J. Bact., 51, 641.
14. Bigg, N.D., Smellie, E.W., and Wright, J. 1947 Dust control in measles wards. Brit. Med. J., 1, 209-215.
15. Bourdillon, R.B., and Lidwell, O.M. 1948 Special Rep. Ser. Med. Research Council, London, No. 262, 173.
16. Bourdillon, R.B., Lidwell, O.M., and Lovelock, J.E. 1942 Sneezing and disinfection by hypochlorites. Brit. Med. J., 1, 42-44.
17. Boyland, E., Gaddum, J.H., and McDonald, F.F. 1947 Nasal filtration of air-borne droplets. J. Hyg., 45, 290-296.
18. Brooks, G.L., Wilson, V., and Blackfen, K.D. 1942 Studies of cross-infection in infants' hospital in Boston. Aerobiology Am. Assoc. Advancement Sci., No. 7, 228-236.
19. Brown, J.G. 1930 Living micro-organisms in the air of the arid southwest. Science, 72, 322-323.
20. Brown, W.A., and Allison, V.D. 1937 Infection of the air of scarlet fever wards with Streptococcus pyogenes. J. Hyg., 37, 1-13.
21. Brown, W.L., and Brown, C.P. 1916 Bacteriology of operating room air and possible relation to wound infection. Texas State J. Med., 12, 256.
22. Browne, A.S. 1949 The public health significance of Salmonella on poultry and poultry products. Ph.D. Thesis, Univ. Calif., Berkeley, Calif.

23. Buchbinder, L. 1942 The bactericidal effects of daylight and sunlight on chained gram positive cocci in simulated room environment: theoretical and practical considerations. Aerobiology, No. 17, 267-270.
24. Buchbinder, L. 1942 The transmission of certain infections of respiratory origin: a critical review. J. Am. Med. Assoc., 118, 718-730.
25. Buchbinder, L., and Phelps, E.B. 1941 Studies on microorganisms in simulated room environments. II. The survival rates of streptococci in the dark. J. Bact., 42, 345-351.
26. Buchbinder, L., and Solotorovsky, M. 1941 Studies on microorganisms in simulated room environments. VI. The disappearance of vaccinia virus from the air. J. Bact., 42, 635-641.
27. Buchbinder, L., Solotorovsky, M., and Solowey, M. 1938 A note on the Beta hemolytic streptococcus of air. Proc. Soc. Exp. Biol. Med., 38, 570-572.
28. Buchbinder, L. Solowey, M., and Phelps, E.B. 1941 The survival rates of streptococci exposed to natural (daylight and sunlight) and artificial light in simulated room environments. J. Bact., 42, 79.
29. Buchbinder, L., Solowey, M., and Phelps, E.B. 1941 Survival rates of streptococci in the presence of natural daylight and sunlight and artificial illumination. J. Bact., 42, 353.
30. Buchbinder, L., Solowey, M., and Solotorovsky, M. 1938 Alpha hemolytic streptococci of air. Their variant forms, origin and numbers per cubic foot of air in several types of locations. Am. J. Pub. Health, 28, 61-71.
31. Buchbinder, L., Solowey, M., and Solotorovsky, M. 1941 Studies on microorganisms in simulated room environments. IV. The effect of survival on the pathogenic properties of streptococci: mouse virulence. J. Bact., 42, 615-630.
32. Buchwald, N.F. 1939 Douglesiens sodskimmel (Phaeocrytopus gaumanni) en ny svamp Poa Douglasgran i Denmark. Dansk., Skovforen Tiosk., 357-382.
33. Bullock, K. and Lightbown, J.W. 1947 Inactivation of enzymes and microorganisms in oils and powders. II. Effects of drying on the viability of bacteria, and their thermolability in powders. Quart. J. Pharm. Pharmacol., 20, 312-328.
34. Burbury, Y.M. 1928 Survival of the (foot-and-mouth disease) virus outside the body. Ann. Applied Biol., 15, 139-142.
35. Caldwell, M.E. 1925 Viability of Mycobacterium tuberculosis in a semi-arid environment. J. Infectious Diseases, 37, 465-472.
36. Caminata, B.H., and Faber, J.E., Jr. 1950 Examination of the air in a crowded gymnasium for the viruses of influenza and herpes simplex. Virginia J. Sci., 1, 111-122.
37. Campbell-Renton, M.L. 1941 Experiments on drying and freezing bacteriophage. J. Path. Bact., 53, 371-384.
38. Cathcart, W.H., Ryberg, R.E., and Merz, A. 1942 Staphylococci and Salmonella control in foods; effect of ultraviolet radiation and ozone on bakery custard and cream fillings. Food Research, 7, 1-9.
39. Cauer, H. 1949 Grippe and the chemistry of air. Grenzgebeite Med., 2, 240-244.

40. Challinor, S.W., and Duguid, J.P. 1944 Propylene glycol vapor as air disinfectant. Edinburgh Med. J., 51, 280.
41. Chief, Military Sanitary Admin. of the Red Army 1944 Manual of Infectious Diseases, Medgiz, Moscow, 201.
42. Cohen, C. 1946 A note on hollyhock rust (*Puccinia malvaccarum*, Mont.) in South Africa. S. African J. Sci., 42, 137-138.
43. Colebrook, L., and Dallas, R.W.P. 1947 Dissemination of streptococci in air. Lancet, 2, 792-794.
44. Colvin, M.G. 1932 Air dissemination of bacteriophage in relation to air-borne infection. Am. J. Hyg., 15, 247-259.
45. Cotter, R.V. 1931 Black stem rust combed from the air by filters. Year Book, U.S. Dep. Agr., 116-118.
46. Crosbie, W.E., and Wright, H.D. 1941 Diphtheria bacilli in floor dust. Lancet, 1, 656-659.
47. Cruickshank, R. 1938 Discussion on streptococcal infection as ascertained by type determination. Lancet, 1, 841.
48. Cruickshank, R., and Muir, C. 1940 Air-borne streptococcal infection following influenza. Lancet, 238, 1155-1160.
49. Dalla Valle, J.M. 1944 Air filters for control of air-borne bacteria. Heating Ventilating Mag., 41, 54-59.
50. De Lay, P.D., Lennette, E.H., De Ome, K.B. 1950 Q fever in California. II. Recovery of *Coxiella burneti* from naturally-infected air-borne dust. J. Immunol., 65, 211-220.
51. De Ome, K.B., et al. 1944 The effect of temperature, humidity, and glycol vapor on the viability of air-borne bacteria. Am. J. Hyg., 40, 239-250.
52. Dickson, E.C., and Gifford, M.A. 1938 Coccidioides infection. Arch. Internal Med., 62, 853.
53. Dillon Weston, W.A.R. 1929 Observations on the bacterial and fungal flora of the upper air. Trans. Brit. Mycol. Soc., 14, 111-117.
54. Du Buy, H., Arnold, F.A., and Olson, B.J. 1947 Air transmission of microorganisms derived from the respiratory tract. I. *Lactobacillus acidophicus* as a test organism. U.S. Pub. Health Repts., 62, 1391-1413.
55. Du Buy, H.G., et al. 1948 Evaluation of ultraviolet radiation of sleeping quarters as supplement of accepted methods of disease control. Am. J. Hyg., 48, 207-226.
56. Duguid, J.P. 1946 The size and the duration of air-carriage of respiratory droplets and droplet-nuclei. J. Hyg., 44, 471.
57. Duguid, J., and Wallace, A. 1948 Air infection with dust liberated from clothing. Lancet, 255, 845-849.
58. Dunklin, E.W., and Puck, T.T. 1948 Lethal effect of relative humidity on air-borne bacteria. J. Exp. Med., 87, 87-101.
59. Durham, O.C. 1941 Methods in aerobiology. J. Aviation Med., 12, 153-162.
60. Eagleton, A.J. 1919 Bacterial content of air in army sleeping huts with especial reference to meningococcus. J. Hyg., 18, 264-271.
61. Edwards, D.G. 1941 Resistance of influenza virus to drying and its demonstration on dust. Lancet, 241, 664-665.
62. Edwards, D.G., Elford, W.S., and Laidlow, P. 1943 Studies on air-borne virus infections. J. Hyg., 43, 1-10.
63. Edwards, D.F.F., and Lidwell, O.M. 1943 Air-borne virus infections; killing of aerial suspensions of influenza virus by hypochlorous acid. J. Hyg., 43, 196-200.

64. Eigelsbach, H.T., Braun, W., and Herring, R.D. 1951 Studies on the variation of Bacterium tularense. J. Bact., 61,557-569.
65. Eisenberg, G.M. 1937 Mycobacterium tuberculosis in air and dust; detection by simple technic. Am. J. Hyg., 26, 138-147.
66. Elford, W.J., and Van den Ende, J. 1942 An investigation of ozone as an aerial disinfectant. J. Hyg., 42, 240-265.
67. Elford, W.J., and Van den Ende, J. 1945 Disinfecting action of hypochlorous acid gas and sprayed solution of hypochlorite against bacterial aerosols. J. Hyg., 44, 1-14.
68. Ernst, H.C. 1900 The transportation of disease by dust. Boston Med. Surg. J., 143, 107-108.
69. Eskey, C.R. 1938 Fleas as vectors of plague. Am. J. Pub. Health, 28, 1305-1310.
70. Faber, H.K., Dong, L., and Silverberg, R.J. 1951 A search for poliomyelitis virus in house dust and a study of drying on the viability of the virus. J. Infectious Diseases, 88, 180-186.
71. Faulwetter, R.C. 1917 Dissemination of the angular leaf spot of cotton. J. Agr. Res., 8, 457.
72. Fazulin, N.S. 1937 Microflora of mountain air. Med. Zhur., 7, 75-78.
73. Ferry, R.M., Farr, L.E., Rose, J., and Blau, M. 1951 A study of freshly generated bacterial aerosols of Micrococcus candidus and E. coli. J. Infectious Diseases, 88, 256-271.
74. Flemming, Dr. 1908 Ueber die Arten und die Verbreitung der lebensfahigen Mikroorganismen in der Atmosphare. Ztschr. F. Hyg. u. Infektionskrankheit, 58, 345-385.
75. Flugge, C. 1921 Die Bedeutung der Verstreuung von Hustentropfchen fur die Verbreitung der Phthise. Ztr. F. Tuberk., 34, 212-228.
76. Furtherer, C.M. 1946 Bacterial flora in cantonment-type surgical ward. Bull. U.S. Army Med. Dept., 5, 100-102.
77. Galambos, J.V. 1942 The use of concentrated calcium chloride solution for the prevention of dust. Bull. War Med., 2, 428.
78. Galli-Valerio, B. 1914 The use of ozone for disinfection of air. Centr. Bakt. Parasitenk., Abt. I., 75, 93-96.
79. Garrod, L.P. 1944 Some observations on hospital dust. Brit. Med. J., 1, 245-247.
80. Gilles, E.C. 1937 Isolation of tetanus bacilli from street dust; its bearing on surgical practice. J. Am. Med. Assoc., 109, 484-486.
81. Goldberg, L.J. 1950 Studies on the experimental epidemiology of respiratory infections. IV. A particle size analyzer applied to the measurement of viable air-borne bacteria. J. Infectious Diseases, 87, 133-141.
82. Goldberg, L., and Shechmeister, I. 1951 Studies on the experimental epidemiology of respiratory infections. V. Evaluation of factors related to the slit sampling of airborne bacteria. J. Infectious Diseases, 88, 243-247.
83. Green, C.A., Challinor, S.W., and Duguid, J.P. 1945 Bacteriological investigation of the air during an epidemic of haemolytic streptococcal throat infection. Ann. Rheumatic Diseases, 5, 36-48.

84. Gruen, L., and Scholtis, K. 1949 Untersuchungen ueber die Anwendung von Triaethylenglykol zur Luftdesinfektion. Zentr. Bakt. I. Abt. Orig., 154, 357-364.
85. Hamburger, M., Jr. 1944 Studies on the transmission of hemolytic streptococcus infections. I. Cross infections in army hospital wards. J. Infectious Diseases, 75, 58-70.
86. Hamburger, M., and Green, M.J. 1946 The problem of the dangerous carrier of hemolytic streptococci. J. Infectious Diseases, 79, 33.
87. Hamburger, M., Jr., Hurst, V., Robertson, O.H., and Puck, T. T. 1945 The effect of triethylene glycol vapor on air-borne Beta hemolytic streptococci in the hospital wards. III. The action of glycol vapors at low relative humidities. J. Infectious Diseases, 77, 177-180.
88. Hamburger, M., Jr., Puck, T.T., Hamburger, V., and Johnson, M.A. 1944 Studies on the transmission of hemolytic streptococcus infections. III. Hemolytic streptococci in the air, floor dust, and bedclothing of hospital wards and their relation to cross infection. J. Infectious Diseases, 75, 79-94.
89. Hamburger, M., Jr., Puck, T.T., and Robertson, O.H. 1945 Effect of triethylene glycol vapor on air-borne Beta hemolytic streptococci in hospital wards. J. Infectious Diseases, 76, 208-215.
90. Harris, T.N., and Stokes, J., Jr. 1945 Summary of a 3-year study of the clinical applications of the disinfection of air by glycol vapors. Am. J. Med. Sci., 209, 152-156.
91. Hart, D. 1937 Control of air-borne pathogenic organisms, with particular reference to the use of special bactericidal radiant energy; preliminary report. Arch. Surg., 34, 874.
92. Hart, D. 1938 Sterilization of air in operating room by bactericidal radiant energy; results in over 800 operations. Arch. Surg., 37, 956-972.
93. Hart, D. 1938 Pathogenic bacteria in air of operating rooms; their widespread distribution and methods of control. Arch. Surg., 37, 521-530.
94. Hart, D. 1940 Is sterilization of air by use of ultra-violet radiation of benefit. J. Surg. Gynec. and Obst., 71, 1420.
95. Hart, D. 1940 Sterilization of air with bactericidal radiation; results from Nov. 1, 1938 to Nov. 1, 1939, with further report as to safety of patients and personnel. Arch. Surg., 41, 334-350.
96. Hart, D. 1941 The importance of air-borne pathogenic bacteria in the operating room. A method of control by sterilization of the air with ultraviolet radiation. J. Am. Med. Assoc., 117, 1610-1613.
97. Hart, D. 1944 Air disinfection in - "Medical Physics". (Chicago, Ill.: Year Book Publishers, Inc.), 1499-1502.
98. Heise, H., and Heise, E. 1948 The distribution of ragweed pollen and Alternaria spores in the upper atmosphere. J. Allergy, 19, 403-407.
99. Heise, H., and Heise, E. 1949 The influence of temperature variations and winds aloft on the distribution of pollens and molds in the upper atmosphere. J. Allergy, 20, 378-382.

100. Henle, W. Sommer, H.E., and Stokes, J., Jr. 1942 Studies on air-borne infection in a hospital ward. II. Effects of ultraviolet irradiation and propylene glycol vaporization on the prevention of experimental air-borne infection of mice by droplet nuclei. 1942 J. Pediat., 21, 577-590.
101. Hewlett, R.T. 1905 The bacteriological examination of air with reference to pollution. J. Prevent. M., London, 13, 294-296.
102. Heymann, B. 1908 Versuche an Meerschweinchen über die Aufnahme inhalierter Tuberkelbazillen in die Lunge. Z. Hyg. Infektionskrankh., 60, 490-507.
103. Hoare, E.D., O'Brien, J.R., and Watkins, A.G. 1943 Dust as vehicle of infection in childrens' wards. Lancet, 2, 666-667.
104. Hollaender, A., DuBuy, H., Ingraham, H., and Wheeler, S.M. 1944 Control of air-borne microorganisms by ultraviolet floor irradiation. Science, 99, 130-131.
105. Horrocks, W.H. 1906 Report of Commission on Mediterranean Fever. (On the duration of life of M. melitensis in unsterilized soil.) Part IV. Harrison and Sons, London.
106. Hunt, E.L. 1933 Contamination of operative wounds by air-borne bacteria; further observations. New Engl. J. Med., 209, 931-933.
107. Huntington, E. 1919 Air control and reduction of death rate after operations. Modern Med., 1, 463-555.
108. Huntington, E. 1920 Purpose and method of air control in hospitals. Modern Hosp., 14, 271.
109. Hyde, G.M., and Higgons, R.A. 1947 Six year report dramatizes value of air sterilization. Hospitals, 21, 77.
110. Jacobi, A. 1894 The production of diseases by sewer air. Tr. Cong. Am. Phys. and Surg., N. Haven, 3, 63-87.
111. Jacobs, W.C. 1940 A discussion of physical factors governing the distribution of microorganisms in the atmosphere. J. Marine Research, 2, 218-224.
112. Jarrett, E. Zelle, M., and Hollaender, A. 1948 Studies of the control of acute respiratory disease among naval recruits. II. Limitations of ultraviolet irradiation in reduction of air-borne bacteria in barracks with low ceilings. Am. J. Hyg., 48, 233-239.
113. Jochimsen, E. 1928 Experimentelle Untersuchungen über die Verstaübbarkeit von Diphtheriebacillen. Z. Hyg. Infektionskrankh., 109, 96-101.
114. Kennedy, N.I. 1905 Rep. Comm. Medit. Fev., Part III, 71.
115. Kirstein, F. 1900 Ueber die Dauer der Lebens Fähigkeit der mit Feinsten Tröpfcchen Verspritzten Mikroorganismen. Z. Hyg. Infektionskrankh., 35, 123-164.
116. Kirstein, F. 1905 Ueber die Dauer der Lebensfahrigkeit von Tuberkelbacillen an flugfahrigen Staubchen. Z. Hyg. Infektionskrankh., 50, 186-214.
117. Klarmann, E.G., Wright, E.S., and Shternov, V.A. 1951 Am. J. Pharm., 123, 42-59.
118. Klimsa, R. 1948 Mnozstvi mikrobu ve vzduchu staji. Casopis Ceskoslov. Vet., 3, 156-167.
119. Knowles, T., and Taylor, A.H. 1950 Spectral radiation involved in photoreactivation of ultraviolet-irradiated cultures of microorganisms. Bact. Proc., 1950, 49.

120. Kopeloff, N., and Morse, S. 1922 What are the atmospheric moisture requirements of bacteria. J. Lab. Clin. Med., 7, 555-560.

121. Kriss, A.E., and Roukina, E.A. 1948 O Prirode bakteriofaga. III. Rol'zashchitnykh killoidov v sokhranenii ustoichivosti bakteriofaga pri denaturiruoushchikh vozdeistviiach. Mikrobiologiya, 17, 240-251.

122. Krueger, A.P. 1944 Laboratory and field studies of glycols and floor-oiling in the control of air-borne bacteria. U. S. Naval Medical Bulletin, 42, 1288-1307.

123. Kruse, W. 1895 Ueber die Hygienische Bedeutung des Lichtes. Z. Hyg., 19, 313-333.

124. Kuenen, W., and Swellengrebel, N. 1913 Die Entamöben des Menschen und ihre praktische Bedeutung. Centr. Bakt. I. Abt. Orig., 71, 378-410.

125. Lachmund, H.G. 1941 Observations relative to the behaviour and control of white pine blister rust in California. Master's Thesis, Univ. of Minnesota.

126. Lambert, E.B. 1929 The relation of weather to the development of stem rust in the Mississippi. Valley Phytopath., 19, 1.

127. Lange, B., and Jochimsen, E. 1927 Microorganisms on dust particles with special regard to influenza bacilli. Z. Hyg. Infektionskrankh., 108, 66-89.

128. Laubach, C.A. 1916 Spore-bearing bacteria in dust. J. Bact., 1, 493.

129. Laurell, G., Lofstrom, G., Magnusson, J.M., and Ouchterlony, O. 1949 Airborne infections. II. A report on the methods. Acta Med. Scand., 134, 189-204.

130. Le Guyon, R.F., and Grooten, O. 1931 Bacteriologic analysis of foggy air. Compt. rend. soc. biol., 106, 601-602.

131. Leif, W.R., and Krueger, A.P. 1950 Studies on the experimental epidemiology of respiratory infections. I. An apparatus for the quantitative study of air-borne pathogens. J. Infectious Diseases, 87, 103-116.

132. Lennette, E.H., and Hartwell, H.W. 1951 Q fever in premises harboring infected goats. Am. J. Hyg., 54, 44-49.

133. Lester, W. 1948 The influence of relative humidity on the infectivity of air-borne influenza A virus (PR 8 Strain). J. Exp. Med., 88, 361-368.

134. Lester, W., Jr., Kaye, S., Robertson, O.H., and Dunklin, E. W. 1950 Factors of importance in the use of triethylene glycol vapor for aerial disinfection. Am. J. Pub. Health, 40, 813-820.

135. Lewis, C.J. 1907 The influence of meteorological and other conditions upon the distribution of bacteria in urban atmosphere. Scot. M. and S.J., Edinburgh, 20, 487-501.

136. Lidwell, O.M. 1946 Bacterial effects of the partial irradiation of a room with ultra-violet light. J. Hyg., 44, 333-341.

137. Lidwell, O.M. 1948 Mechanism of aerial bactericidal action. Med. Research Council (London), Spec. Rept. Ser., 262, 104-122.

138. Lidwell, O.M., and Lovelock, J.E. 1946 Some methods of measuring ventilation. J. Hyg., 44, 326-332.

139. Lidwell, O.M., and Lovelock, J.E. 1948 Behavior of disinfectant vapors after dispersal in air. Med. Research Council (London), Special Rept. Ser., 262, 122-130.
140. Lidwell, O.M., Lovelock, J.E., and Raymond, W.F. 1948 Lactic acid as an air disinfectant. Med. Research Council (London), Special Report Ser., 262, 82-87.
141. Lidwell, O.M., and Lowbury, E.J. 1950 The survival of bacteria in dust. I. The distribution of bacteria in floor dust. J. Hyg., 48, 6-20.
142. Lidwell, O.M., and Lowbury, E.J. 1950 The survival of bacteria in dust. II. The effect of atmospheric humidity on the survival of bacteria in dust. J. Hyg., 48, 21-27.
143. Lidwell, O.M., and Lowbury, E.J. 1950 The survival of bacteria in dust. III. The effect of light on the survival of bacteria in dust. J. Hyg., 48, 28-37.
144. Lidwell, O.M., and Lowbury E.J. 1950 The survival of bacteria in dust. IV. Atmospheric humidity and the bactericidal action of ultra-violet irradiation. J. Hyg., 48, 38-43.
145. Lochhead, A.G. 1938 Bacteria in dust-laden snow. Science, 87, 487.
146. Löffler, W., and Mooser, H. 1942 Zum Ubertragungsmodus des Fleckfiebers. Schweiz. med. Wochschr., 72, 755-777.
147. Loosli, C.G., Lemon, H., Robertson, O., and Appel, E. 1943 Experimental air-borne influenza infection. I. Influence of humidity on survival of virus in air. Proc. Soc. Exp. Biol. Med., 53, 205.
148. Loosli, C.G., Lemon, H.M., Wise, H., and Robertson, O.H. 1948 Studies on the transmission and control of respiratory disease within army barracks. I. Hemolytic streptococcal contamination of the environment. J. Infectious Diseases, 82, 59-71.
149. Loosli, C.G., Wise, H., Lemon, H.M., Puck, T.T., and Robertson, O.H. 1946 The oil treatment of bedclothes for the control of dust-borne infection. Am. J. Hyg., 43, 105-119.
150. Lowbury, E.J. 1950 The persistence of dust in occupied rooms. J. Hyg., 48, 1-5.
151. Luckiesh, M., and Holladay, L.L. 1942 Tests and data on disinfection of air with germicidal lamps. General Electric Rev., 45, 223-231.
152. MacLachlan, J.D. 1935 The dispersal of viable Basidiospores of the Gymnosporangium rusts. J. Arnold Arboretum, 16, 411-422.
153. MacLean, A.L. 1918 Bacteria of ice and snow of Antarctica. Nature, 102, 35-39.
154. Matuso, Y. 1943 Seasonal variation of air-borne bacteria and dust in textile mill. Far East. Sc. Bull., 2, 33-34.
155. Maximov, A.A. 1947 Basic types of tularemia vectors, their characteristics and geographical distribution in the RSFSR. Proc. Acad. Sci. U.S.S.R., 57, 501-503.
156. Meier, F.C., Stevenson, J.A., and Charles, V.K. 1933 Spores in the upper air. Phytopath., 25, 27.

157. Meissner, O. 1940 Die Grippeepedemie 1939 und das Wetter. Bioklimatische Beiblatter, 7, 42-43.
158. Miles, A.A., et al. 1940 Hospital infection of war wounds. Brit. Med. J., 11, 855-895.
159. Miller, B.F., and Baker, Z. 1942 Sterilization of air by means of germicidal aerosol mists and vapors. Aerobiology,#17, 271-280.
160. Miller, W.R., Jarrett, E.T., Wilman, T.L., Hollaender, A., Brown, E.W., Lewandowski, T., and Stone, R.S. 1948 Evaluation of ultraviolet and dust control measures in control of respiratory disease at a naval training center. J. Infectious Diseases, 82, 86-100.
161. Mitchell, R.B., Stumm, P.W., Dorris, H.W., and Timmons, D.E. 1949 Studies on microorganisms of the upper atmosphere. Sch. of Av. Med. Proj. # 21-02-118, 5.
162. Mudd, S. 1944 Current progress in sterilization of air. Am. J. Pub. Health, 34.
163. Müller, F. 1940 Die wissenschaftliche und technische Bedeutung der Aerosole. 1940 Kolloid Z., 90, 1-10.
164. National Research Council 1947 Recent studies on disinfection of air in military establishments. Am J. Pub. Health, 37, 189-198.
165. Niles, N.R. 1946 Air sterilization. Arch. Pediat., 63, 266-279.
166. Noguchi, H. 1918 Further studies on the properties of pure vaccine virus cultivated in vivo. J. Exp. Med., 27, 425-442.
167. Ochoa, A.G., and Orozco, C. 1943 Fungi in air of Mexico, D.F.; relation to atmospheric factors. Rev. D. Inst. Salub. Y Enferm. Trop., 4, 259-264.
168. Oesterle, P., and Braünert, R. 1938 Verschiede im Keimgehalt der Luft in verschiedener Höhe über dem Arbeitsplatz unter Verwendung des löslichen Trockenfilters. Arch. Hyg. u. Bakt., 120, 295-303.
169. Osler, W. 1901 Practice of Medicine (4th Ed.).
170. Ostertag, H. 1943 Uber die Hygienische Bedeutung des Grobstadt Strabenstaubes und die Darin Enthaltenen Mikroorganismen. Z. Hyg. Infektionskrankh., 123, 698-708.
171. Ouchterlony, O. 1949 Airborne infections. III. Infections and spreading of infection in diphtheria with special reference to isolation wards. Acta. Med. Scand., 134, 296-309.
172. Pacheco, Genesio, e Gobert Araujo Costa 1941 Influencia do oxigenio sob pressao sobre o "Clostridium welchii." Rev. Brasileira Biol., 1, 145-153.
173. Parker, E.R., Dunham, W.B., MacNeal, W.J. 1944 Resistance of the Melbourne strain of influenza virus to desiccation. J. Lab. Clin. Med., 29, 37-42.
174. Parvis, D. 1948 Relation between high buildings and airborne infections. Riv. ital. d'ig., 7, 35-56.
175. Personnel of U.S. Navy Laboratory Research Unit No. 1 1943 Air-borne infections. War Med., 4, 1-30.
176. Phelps, E.B., and Buchbinder, L. 1941 Studies on microorganisms in simulated room environments. I. A study of the performance of the Wells air centrifuge and of settling rates of bacteria through air. J. Bact., 42, 321-344.

177. Post, M.H. 1945 Dust-borne infection in ophthalmic surgery. Trans. Am. Ophthalmol. Soc., 43, 79-97.
178. Potter, T.S. 1944 Possibility of prevention of tuberculosis by non-poisonous chemical air disinfection and by killed vaccines. Science, 99, 406-407.
179. Pressman, R. 1937 The isolation of pathogenic bacteria from the air. Am. Rev. Tuberc., 35, 815.
180. Proctor, B.E. 1934 The microbiology of the upper air. I. Proc. Am. Acad. Arts Sci., 64, 315-340.
181. Proctor, B.E. 1935 The microbiology of the upper air. J. Bact., 30, 363-375.
182. Proctor, B.E., and Parker, B.W. 1942 Microorganisms in the upper air. Aerobiology, 48-54., # 17.
183. Puck, T.T., Hamburger, M., Jr., Hurst, V., and Robertson, O.H. 1945 Effect of triethylene glycol vapor on air-borne beta hemolytic streptococci in hospital wards; combined action of glycol vapor and dust control measures. J. Infectious Diseases, 76, 216-225.
184. Puck, T.T., Robertson, O.H., Lemon, H. M. 1943 The bactericidal action of propylene glycol vapor on microorganisms suspended in air. II. The influence of various factors on the activity of the vapor. J. Exptl. Med., 78, 387-406.
185. Pulvertaft, R.J.V. 1947 Air-borne infection. Brit. Med. J., 2, 517-520.
186. Puntoni, V. 1947 Aerial navigation and danger of cholera. Riv. Med. Aeronaut., 10, 465-471.
187. Ransom, A., and Delepine, S. Proc. Roy. Soc., No. 336.
188. Ransom, S.E., and Huebner, R.J. 1951 Studies on the resistance of Coxiella burneti to physical and chemical agents. Am. J. Hyg., 53, 110-
189. Ransome, A. and Foulerton, A.G.R. 1901 Ueber den Einfluss des Ozons auf die Lebenskraft Einiger Pathogenen und Anderen Bakterien. Centr. Bakt., Parasitenk. I. Abt., 29, 900-908.
190. Rentschler, H.C. 1940 Bactericidal ultraviolet radiation and its uses. Ann. Convention of Illuminating Eng. Soc., 34, 1-16.
191. Rentschler, H.C. 1941 Bactericidal action of ultraviolet radiation. J. Bact., 42, 292.
192. Rentschler, H.C., and Nagy, R. 1940 Advantages of bactericidal ultraviolet radiation in air conditioning systems. Heating, Piping, and Air Conditioning, 12, 127.
193. Rentschler, H.C., Nagy, R., and Mouromseff, G. 1941 Bactericidal effect of ultraviolet radiation. J. Bact., 41, 745.
194. Rice, T.B., Weed, L.A., and Reidt, H. 1941 Bacterial content of air in the operating rooms. Surg., Gynecol. and Obstet., 73, 181-192.
195. Robb, H. 1909 The air of the operating room as a possible factor in the infection of wounds. Trans. Am. Gynecol. Soc., 34, 550-564.
196. Robertson, E.C. 1940 Ultraviolet light in hospital practice. Hospitals, 14, 115-118.
197. Robertson, O.H. 1942 Sterilization of air with glycol vapors. Harvey Lectures, 38, 227-254.
198. Robertson, O.H. 1943 Air-borne infection. Science, 97, 495-502.

199. Robertson, O.H. 1944 A new Approach to the control of air-borne infection. Trans. Assoc. Am. Physicians, 58, 171.
200. Robertson, O.H. 1947 The dangerous carrier of hemolytic streptococci. Am. J. Med., 2, 324-326.
201. Robertson, O.H. 1947 The dispersal of respiratory pathogens in relation to the occurrence and control of air-borne infections. Am. Rev. Tuberc., 55, 109-123.
202. Robertson, O.H. 1949 Disinfection of the air with triethylene glycol vapor. Am. J. Med., 7, 293-296.
203. Robertson, O.H., Dunklin, E.W., Puck, T.T., and Lester, W., Jr. 1948 The influence of relative humidity on the survival of respiratory pathogens dispersed into the environment. Trans. Assoc. Am. Physicians, 61, 280.
204. Robertson, O.H., and Hamburger, M. 1948 Expulsion of group A hemolytic streptococci in droplets and droplet nuclei by sneezing, coughing, and talking. Am. J. Med., 4, 690-701.
205. Robertson, O.H., Hamburger, M., Jr., Loosli, C.G., Puck, T. T., Lemon, H.M., and Wise, H. 1944 A study of the nature and control of air-borne infection in army camps. J. Am. Med. Assoc., 126, 993-1000.
206. Robertson, O.H., Lester, W., Jr. 1951 The lethal effect of triethylene glycol vapor on dried air-borne bacteria. Am. J. Hyg., 53, 69-79.
207. Robertson, E.C., Doyle, M.E., Tisdall, F.F., Koller, L.R., and Ward, F.S. 1939 Air contamination and air sterilization. Am. J. Diseases Children, 58, 1023-1038.
208. Robertson, O.H., Puck, T.T., Loosli, C.G., Hamburger, M., Jr., Lemon, H.M., and Wise, H. 1944 New approach to control of air-borne infection. Trans. Assoc. Am. Physicians, 58, 171-174.
209. Rochaix, A. 1931 L'humidite atmospherique- son role pathogene. Le Movement Sanitaire, 7, 524.
210. Rogers, J.B. 1920 Studies on the viability of the tubercle bacillus. Am. J. Pub. Health, 10, 345.
211. Rogers, L. 1928 Small-pox virus and climate in England and Wales. Brit. Med. J., 1, 300-302.
212. Rogers, L.A., and Meier, F.C. 1936 An apparatus for collecting bacteria in the stratosphere. J. Bact., 31, 27.
213. Rogers, L.A., and Meier, F.C. 1937 The collection of microorganisms above 36,000 feet. Nat. Geographic Soc., Contributed Tech. Papers, Stratosphere Series, 2, 146-151.
214. Rooks, R. 1939 The bacterial filtering efficiency of the human nose. Am. J. Hyg., 30, 7.
215. Rosebury, T. 1947 Experimental air-borne infection. Williams and Wilkins Co., Baltimore.
216. Rosen, H.R. 1936 The influence of dry air on the longevity of the fire blight pathogen. Phytopathology, 26, 439-449.
217. Rosenstern, I. 1942 Observations on the control of respiratory contagion in the Cradle. Aerobiology Am. Assoc. Advancement Sci., 242-250.
218. Rosenstern, I. 1948 Control of air-borne infections in a nursery for young infants. Am. J. Diseases Children, 75, 193-202.

219. Rossi, C. 1924 Sull'azione Battericida Della Luce Solare In Profondita. Ann. ital. di Chir., Napoli, 3, 1000-1020.
220. Rountree, P.M., and Armytage, J.E. 1946 Hospital blankets as source of infection. Med. J. Australia, 1, 503-506.
221. Roussakov, L.F. 1926 Notes on a survey in 1925 of the incidence of cereal rusts in Amur. Golt. Morbi. Plantarum, Leningo, 4, 28.
222. Rowe, A.H. 1933 Medical aspects of conditioned air. Med. J. and Record, 138, 345-349.
223. Sauer, L.W., Minsk, L.D., and Rosenstern, I. 1942 Control of cross infections of the respiratory tract. J. Am. Med. Assoc., 118, 1271-1274.
224. Savage, N.I. 1903 J. of Sanit. Inst., 24, 442.
225. Sharp, D.G. 1938 A quantitative method of determining the lethal effect of ultraviolet light on bacteria suspended in air. J. Bact., 35, 589-599.
226. Sharp, D.G. 1939 The lethal action of short ultraviolet rays on several common pathogenic bacteria. J. Bact., 37, 447-460.
227. Sharp, D.G. 1940 Effects of ultraviolet light on bacteria suspended in air. J. Bact., 39, 535-547.
228. Shechmeister, I.L., and Greenspan, F.S. 1947 The relation of the oil treatment of floors and bedding to the control of respiratory diseases among naval personnel. Am. J. Hyg., 46, 376-407.
229. Shechmeister, I.L. 1950 III. Certain aspects of the behaviour of type A influenza virus as an air-borne cloud. J. Infectious Diseases, 87, 128-132.
230. Shechmeister, I.L., and Goldberg, L.J. 1950 Studies on the experimental epidemiology of respiratory infections. II. Observations on the behaviour of aerosols of Streptococcus zooepidemicus. J. Infectious Diseases, 87, 116-127.
231. Shechmeister, I.L. 1950 Studies on the experimental epidemiology of respiratory infections. III. Certain aspects of the behaviour of type A influenza virus as an air-borne cloud. J. Infectious Diseases, 87, 128-132.
232. Sim , R.P., and Flinn, F.B. 1939 Hazard from tubercle bacilli in environmental air. Am. J. Hyg., 30, 135-140.
233. Skrsynska, J. 1949 The microbiological examination of the troposphere; meteorological influence. Med. Doswiadczalna i Microbiol., 1, 294-343.
234. Smadel, J.E. 1951 The hazard of acquiring virus and rickettsial diseases in the laboratory. Am. J. Pub. Health, 41.
235. Smith, C.E. 1943 Coccidioidomycosis. Med. Clinics N. Amer., 27, 790.
236. Smith, C.E., Beard, R.R., Rosenberger, H.G., Whiting, E.G. 1946 Effect of season and dust control on coccidioidomycosis. J. Am. Med. Assoc., 132, 833-838.
237. Smyth, H.F., and Pike, E.F. 1921 Disinfecting skins and hair for anthrax. Am. J. Hyg., 1, 541-555.
238. Sonkin, L.S. 1951 The role of particle size in experimental air-borne infection. Am. J. Hyg., 53, 337-354.

239. Soule, M.H. 1934 A microorganism carried by the dust storm. Science, 80, 14-15.
240. Stakman, E.C. 1934 Epidemiology of cereal rusts. Proc. Fifth Pacific Science Congress, 1933, 4, 3177-3184.
241. Stakman, E.C., Henry, A.W., Curran, G.C., and Christopher, W.N. 1923 Spores in the upper air. J. Agr. Research, 24, 599-606.
242. Stillman, E.G. 1917 Further studies on the epidemiology of lobar pneumonia. J. Exp. Med., 26, 513-534.
243. Sulkin, S.E., and Pike, R.M. 1951 Survey of laboratory-acquired infections. Am. J. Pub. Health, 41, 1-13.
244. Teague, O., and Barber, M.A. 1912 Studies on pneumonic plague and plague immunization. Philippine J. Sci., 7, 255-268.
245. Thomas, J.C. 1941 Infection from dust. Lancet, 1, 433.
246. Thomas, J.C. 1941 Reduction of dust-borne bacteria by oiling floors. Lancet, 123-127.
247. Thomas, J.C., and Van den Ende, M. 1941 Reduction of dust-borne bacteria in the air of hospital wards by liquid paraffin treatment of bedclothes. Brit. Med. J., 953-958.
248. Timmons, D.E., Anderson, D.T., Dorris, H.W., and Mitchell, R.B. 1949 Studies on microorganisms of the upper atmosphere. School of Av. Med., Report No. 3, 2.
249. Trevelyan, E.F. 1898 Behavior of the diphtheria bacillus outside the human body. J. San. Inst. 1897, London, 18, 430-434.
250. Twort, C.C., and Baker, A.H. 1940 Effect of smoke on bacteria in air: effect on salivary organisms, smoke concentration, persistence tests, biological experiments. Lancet, 239, 587-589.
251. Walker, G. 1935 Bacterial content at high altitudes. Science, 82, 442-443.
252. Wells, W.F. 1935 Air-borne infection and sanitary air control. J. Ind. Hyg., 17, 253-257.
253. Wells, W.F. 1940 Biological factors involved in the bactericidal irradiation of air. J. Bact., 39, 18.
254. Wells, W.F. 1941 Infection, disinfection, and air conditioning. Ind. Med., 10, 281-282.
255. Wells, W.F. 1945 Sanitary ventilation by radiant disinfection. Science Monthly, 60, 325-334.
256. Wells, W.F. 1945 Circulation in sanitary ventilation by bactericidal irradiation of air. J. Franklin Inst., 240, 379-395.
257. Wells, W.F., and Brown, H.W. 1936 Recovery of influenza virus suspended in air and its destruction by untraviolet radiation. Am. J. Hyg., 24, 407-413.
258. Wells, W.F., and Fair, G.M. 1935 Viability of B. coli exposed to ultraviolet radiation in air. Science, 82, 280-281.
259. Wells, W.F., Ratcliffe, H.L., and Crumb, C. 1948 Quantitative experimental air-borne tuberculosis in rabbits. Am. J. Hyg., 47, 11-28.
260. Wells, W.F., and Riley, E.C. 1937 The bacterial contamination of the air of textile mills with special reference to the influence of artificial humidification. J. Ind. Hyg. Toxicol., 19, 513-561.

261. Wells, W.F., and Stone, W.R. 1934 On air-borne infection. II. Droplets and droplet nuclei. III. Viability of droplet nuclei infection. Am. J. Hyg., 20, 611-618, 619-627.
262. Wells, W.F., and Wells, D. 1940 Quantitating Gordon's bacteria test for estimating pollution of air. J. Bact., 39, 755-756.
263. Wells, W.F., and Wells, M.W. 1936 Air-borne infection. J. Am. Med. Assoc., 107, 1698-1703.
264. Wells, W.F., and Wells, M.W. 1943 Dynamics of air-borne infection. Am. J. Med. Sci., 206, 11-17.
265. Wells, W.F., Wells, M.W., and Mudd, S. 1939 Infection of air. Bacteriologic and epidemiologic factors. Am. J. Pub. Health, 29, 863-880.
266. Wells, W.F., Winslow, C.E.A., and Robertson, E.C. 1946 Bacteriologic procedures in the evaluation of methods for control of air-borne infection. Am. J. Pub. Health, 36, 324-331.
267. Wells, W.F., and Zappasodi, P. 1942 The effect of humidity on beta streptococci (group C) atomized into air. Science, 96, 277-278.
268. Weston, W.H., Jr. 1923 Production and dispersal of Conidia in the Philippine Sclerosporas of Maize. J. Agr. Res., 23, 239.
269. Whistler, B.A. 1940 The efficacy of ultraviolet light sources in killing bacteria suspended in air. Iowa State Coll. J. Sci., 14, 215-231.
270. White, E. 1936 Lancet, 1, 941.
271. Wilimon, T., Hollaender, A., and Langmuir, A. 1948 Studies on the control of acute respiratory diseases among naval recruits. I. A review of a four-year experience with ultraviolet irradiation and dust suppressive measures 1943 to 1947. Am. J. Hyg., 48, 227-232.
272. Williams, R.E.O. 1949 Examination of floor dust for haemolytic streptococci. J. Hyg., 47, 416-425.
273. Williamson, A.E., and Gotaas, H.B. 1942 Aerosol sterilization of airborne bacteria. Ind. Med. II, Ind. Hyg. Sect. 3, 40-45.
274. Willits, R.E., and Hare, R. 1941 The mechanism of cross infection of wounds in hospitals by hemolytic streptococci. Canad. Med. Assoc. J., 45, 479-488.
275. Winslow, C.E.A., and Kligler, I.J. 1912 A quantitative study of the bacteria in city dust with special reference to intestinal and buccal forms. Am. J. Pub. Health, 2, 663-696.
276. Wright, H.D., Shone, H.R., and Tucker, J.R. 1941 Cross infection in diphtheria wards. J. Path. Bact., 52, 111-128.
277. Zeiss, H. 1926-1942 Tularemia epidemic in southeastern Russia. Seuchen- Atlas.
278. ZoBell, C.E. 1934 Microbiological activities at low temperatures with particular reference to marine bacteria. Quart. Rev. Biol., 9, 460-466.
279. ZoBell, C.E., and Mathews, H.M. 1936 A qualitative study of the bacterial flora of land and sea breezes. Nat. Acad. Sci. Proc., 22, 567-572.

References (Air) Addendum

1a. Aimes, A. 1933 Humidity and the propagation of infectious diseases. Rev. d'Hyg., 55, 614-621.

2a. Appling, J.W., and Tanner, F.W. 1941 Bactericidal effect of Ultra-Violet rays (sterilamp) on microorganisms on the restaurant glassware. Proc. Soc. Exptl. Biol. and Med., 47, 51-54.

3a. Bang, B. 1897 Die Actiologic Des Schuchenhaften (Infectiosen) Verwerfens (Abortus). A.F. Their, 1, 214-278.

4a. Bey, M.K, 1948 Effect of absolute humidity of atmosphere on first wave of Cholera epidemic in Egypt in 1947. Jour. Roy. Egyptian M.A., 31, 39-72.

5a. Bloomfield, A.F., 1919 Fate of bacteria introduced into upper air passages. Bull. Johns Hopkins Hosp., 30, 317.

6a. Buttolph, L.J. 1944 Physical basis of air disinfection by ultraviolet energy. Arch. Phys. Therapy, 25, 671-682.

7a. Buttolph, L.J. 1945 Principles of Ultra-Violet disinfection of enclosed spaces, 17, 282.

8a. Cambier, M.R. 1929 Bull. Acad. Med., 102, 13.

9a. Cruickshank, R. et al 1947 Discussion: Modern methods in control of air-borne infections, Proc. Roy. Soc. Med. 40, 381-383.

10a. Dautrebande, L, Highman, B., Alford, W.C., and Weaver, F.L. 1948 Studies on aerosols with an average mean micellary diameter under one-half micron. Study of the agglutination of liquid micellae, Arch. Internatl. Pharmacodyn. et Ther. 76, 247-273.

11a. Dingle, J.H., Abernathy, I.J., Badger, G.F., Beard, J.W., Cressy, N.L., Feller, A.E., Gordon, I., Langmuie, A.D., Rammelkamp, C.H., Strauss, E., and Tatlock, H. 1946 A study of the effect of oiled floors and bedding on the incidence of respiratory disease in new recruits. Amer. Jour. of Hyg., 43, 120-144.

12a. Gärtner, K. 1947 Zur unterschiedlichen Wirkung ultravioletter Strahlen auf grampositive und gramnegative Bakterien. Aeitschr. Hyg. u. Infektionskrankh, 127, 273-279.

13a. Gilcread, F., Wellington, and Roberts, Hazel, V. 1950 Bacteriologic studies in disinfection of air in large rural central schools. 1. Ultra-Violet irradiation, Amer. Jour. Publ. Health, 40, 808-812.

14a. Hart, D., Devine, J.W., and Martin, D.W. 1939 Bactericidal effect of ultraviolet radiation; use of special unit for sterilizing air in operating room., Arch. Surg. 38, 806-815.

15a. Heppleston, A.G. 1949 Quantitative airborne tuberculosis in the rabbit: The course of human type infection., Jour. Exptl. Med. 89, 597-609.

16a. Hollaender, A. 1942 Aerobiology. Publ. Amer. Assoc. for Advancement Sci., 17, 156-165.

17a. Hollaender, A. 1943 Ultra-Violet irradiation as means of disinfection. Amer. Jour. Publ. Health, 33, 980-984.

18a. Kaplan, Leo. 1949 A survey of air-borne fungi of the Boston area in relation to inhalant allergy. Amer. Jour. Bot., 36, 810.

19a. Luckiesh, Matthew, Taylor, A.A., and Knowles, I. 1947 Killing air-borne respiratory microorganisms with germicidal energy. Jour. Franklin Inst., 244, 267-290.
20a. Mackinnon, Juan, E. 1949 The dependence on the weather of the incidency of Sporotrichosis. Mycophologia, 4, 367-374.
21a. Parvis, D. 1941 Bacteria in air-conditioned rooms. Ann. Dig., 51, 457-464.
22a. Pennington, L.H. 1925 Relation of weather conditions to the spread of white pine blister r ust in the Pacific North-West. Jour. Agr. Res., 30, 593-607.
23a. Pettigrew, W.W. 1928 The influence of air pollution on vegetables. Gardener's Chron., 84, 292, 308-309, 335.
24a. Phelps, Earle B., Buchbinder, Leon 1939 Symposium on air-borne infections. Third Internatl. Congr. Microbiol. Rept. Proc., 266-273.
25a. Polding, J.B. 1950 Brucellosis in India. Indian Vet. Jour., 27, 156-170.
26a. Puck, Theodore T. 1947 The mechanism of aerial disinfection, by glycols and other chemical agents. Jour. Exptl. Med., 85, 729-757.
27a. Ray, Bahabir 1950 Incidence of cholera and its dependence on seasonal factors., 15, 311-313.
28a. Rivers, Thomas, M. 1939 Viruses and virus diseases. Bk. Stanford Univ. 134.
29a. Roger, L. 1944 Cholera incidence in India in relation to rainfall, absolute humidity and pilgramages. Tr. Roy. Soc. Trop. Med., & Hyg., 38, 73-94.
30a. Rogers, Leonard 1948 Further work on forecasting smallpox epidemics in India and British tropical countries based on previous clinical data. Jour. Hyg., 46, 19-23.
31a. Roux, E. 1887 De L'action De La Lumiere et De L'air. Ann. Inst. Pasteur, 1, 445.
32a. Sawinzky 1891 Zur Frage uber die Dauer der infectiosen Eigenschaften des getrockneten tuberculosen. Sputums. Dissert. Inaug., 11, 153, 1892.
33a. Schlotthauer, H.L. 1940 Aircraft as disease carriers. California and Western Med., 53, 33.
34a. Sweany, H.C. and MacLane, C.C. 1919 Relation of dust to spread of tuberculosis. Ill. Med. Jour., 36, 302-305.
35a. Teague, O. 1913 Some experiments bearing upon droplet infection in diphteria., Jour. Inf. Dis., 12, 398-414.
36a. Thomson, St. C. and Hewlett, R.T. 1896 The fate of micro-organisms in inspired air., 1, 86.
37a. Vandecaveye, S.C. 1927 Effect of moisture temperature, and other climatic conditions on R. Leguminosarum in the soil. Soil. Sci., 23, 355-362.
38a. VandenEnde, M., Edward, D.G., and Lush, Dora 1941 Reduction of dust-borne infection by treatment of bedclothes. Med. Bull. Lancet, 2, 427-428.
39a. Wildführ, B. 1947 Influence of climate on spread of communicable disease. Ärztl. Forsch., 1, 223-227.
40a. Williams, R.E.O. 1949 Examination of floor dust for haemolytic streptococci., 47, 416-425.

ADDENDUM (Air)

1a. Allen, L.A. 1940 Influence of aeration on bacterial growth and on associated chemical changes. Soc. Agr. Bact. (Gt. Brit), 14-18.

2a. Ayres, J.C. 1948 Epidemiology of tularemia in Massachusetts with review of the literature. New Eng. J. Med., 238, 187-194.

3a. Baker, A.H., and Twort, C.C. 1944 Germicical mists and vapors in air disinfection. J. Hyg., 43, 382-394.

4a. Barenberg, L.H., Greene, D., and Greenspan, L. 1940 Effect of irradiation of air in ward on incidence of infections of resp- tract. Am. J. Dis. Child., 59, 1219-1226.

5a. Barrett, T. 1947 Pioneer in the use of triethylene glycol for air sterilization. New Power, 6, 83-85.

6a. Bechhold, H. 1937 Destruction of moving air-borne microorganisms by means of irradiated substances. Ztschr. F. Hyg. u. Infektionskr., 119, 193-212.

7a. Breinl, F., and Hofmann, R. 1935 Uber die Sterilisationsleistung bewegter Heissluft. Arch. Hyg. u. Bakt., 113, 305-312.

8a. Bucheinder, L. The transmission of certain infections of respiratory origin: A critical review. J. Am. Med. Assoc., 118, 718-730.

9a. Catalano, G., and Oddo, F. (U. Palermo) 1948 Sulla disinfezione dell'aria. IV. Azione dei vapori di acido lattico sul virus influenzale. (Air disinfection. IV. Action of the vapors of lactic acid on the influenza virus.) Boll. Soc. Ital. Biol. Sperim., 24, 124-126.

10a. Durnbell, K., Lovelock, J., and Lowbury, E. 1948 Handkerchiefs in the transfer of respiratory infections. Lancet, 255, 183-185.

11a. Flugge, C. 1897 Ueber Luftinfection. (Air-borne infection). Ztr. f. Hyg. u. Infekt., 25, 179-224.

12a. Hamburger, M., Robertson, O.H., and Puck, T.T. 1945 The present status of glycol vapors in air sterilization. Am. J. Med. Sci., 209, 162-166.

13a. Hewlett, R.T. 1939 Tolerance of phenol vapor. Lancet, 1, 664, 1126.

14a. Hirst, G.K. 1943 Adsorption of influenza virus on cells of the respiratory tract. J. Exptl. Med., 78, 99.

15a. Hollaender, A. 1946 The use of ultraviolet radiation in air disinfection. J. Bact., 51, 639-640.

16a. Lemon, H.M., Loosli, C.G., and Hamburger, M., Jr. 1948 The transmission and control of respiratory disease in army barracks. J. Infectious Diseases, 82, 72-85.

17a. Lemon, H.M., Wise, H., and Hamburger, M., Jr. 1944 Bacterial content of air in army barracks. Results of a study with especial reference to the dispersion of bacteria by the air circulation system. War Medicine, 6, 92-101.

18a. Long, E.R. 1951 The hazard of acquiring tuberculosis in the laboratory. Am. J. Public Health, 41.

19a. Lovelock, J.E. 1948 Aliphatic α-hydroxycarboxylic acids as air disinfectants. Med. Research Council (London), Special Rept. Ser., 262, 89-104.

20a. Lovelock, J.E., Lidwell, O.M., and Raymond, W.F. 1944 Vaporization of lactic acid as aerial bactericide. Nature, London, 153, 743.

21a. Lurie, M.B., Tomlinson, H., and Abramson, S. 1944 The prevention of natural air-borne contagion of tuberculosis in rabbits by UV radiation. J. Bact., 48, 257-258.
22a. Nisbet, O.M., and Brooke, J.W. 1938 Incidence of air-borne bacteria in major surgery of Multnomah County Hospital. Surgery, 4, 755-761.
23a. Perkins, J.E. 1947 Present status of the control of air-borne infections. Am. J. Public Health, 37, 13-22.
24a. Rentschler, H.C., and Nagy, R. 1939 The effect on bacteria of UV radiation. Science (Supplement), 89, 8.
25a. Robertson, O.H., Appel, E.M., Puck, T.T., Lemon, H.M., and Ritter, M.H. 1948 A study of the bactericidal activity in vitro of certain glycols and closely related compounds. J. Infectious Diseases, 83, 124-137.
26a. Rosenow, E.C. 1945 Specific types of alpha streptococci and streptococcal precipitinogen in air. J. Lancet, 65, 93-131.
27a. Wells, W.F. 1943 Air disinfection of day schools. Am. J. Public Health, 33, 1436-1443.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN THE BODY (AND BODY MATERIALS)

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN THE BODY

(AND BODY MATERIALS)

TABLE #	TABLE OF CONTENTS (CONT'D)	PAGES

TABLE B1 THE SURVIVAL OF BACILLUS ANTHRACIS IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
Blood, R.T., moist spores	60-90 d.	Minett	1950
" " dry.	"	"	
G.P. blood, 25-30 C., opened before decomposition	1-9 mos.	Stein	1947
G.P. Blood stored 5-10 C.	35-159 d.	"	
FECES			
G.P. feces	Spores in 7 of 19	Stein	1947
SKIN			
100% inhibited by normal human skin		Hill	1933
URINE			
Urine of G.P.	Vegetative forms in 19 of 28 cases	Stein	1947
TISSUE, GENERAL			
Muscle, G.P., 25-30 C., Opened before decomposition	6-7 mos.	Stein	1947
Liver & bone marrow, G.P, 25-30 C., opened before decomposition	6 mos.	"	
Spleen, opened before decomposition, R.T.	3 mos.	"	
Stored 5-10 C.	14-24 d.	"	
Continuous freezing, spleen, -60 to -70 C., G.P.	Destroyed in 90 d.	"	
Carcass of unopened G.P., 25-30 C.	Few alive in 72-80 h.	"	
Carcass of unopened G.P., 5-10 C.	4 wks.	"	
Carcass of unopened G.P., R.T.	9 mos.	"	

TABLE B2 THE SURVIVAL OF BORRELIA, LEPTOSPIRA, SPIRILLUM AND TREPONEMA SPECIES IN THE BODY. (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
B. recurrentis			
Defibrinated, refrigerated sheeps blood	195 d.	Beck	1937
Infected blood, Inoc. into physiol. saline with boiled egg white	Still viable 3-4 wks.	Krantz	1925
At ice box temp.	" " 4 d.	"	
Rat blood, -48 C.	Remained infective for mice 27 mos.	Lofgren	1945
Iced blood	1 wk.	Toyoda	1931
Rat blood, -12 to -20 C.	Infectivity markedly reduced, 6 wks.	Turner	1939
" " -78 C., Cooling	2-6 h.	"	
-78 C. to 0 C.	2-6 H.	"	
Clotted blood, R.T.	6 d.	Wynns	1935
0 C.	100 d.	"	
L. icterohemorrhagica			
Blood, defibrinated, R.T.,	Still infective 7 d.	Uhlenhuth	1916
light of day, 45 C.	" " 15 min.	"	
S. minus			
Frozen	1 yrs.	Turner	1939
S. rubrum			
Sterile rabbit blood susp.	at least 5 yrs.	Frobisher	1947
T. pallidum			
Citrated blood & plasma stored at 5 C.	Occasionally at 48 & 72 hrs. Not after 72 hrs.	Bock	1941
Human blood & plasma, 5 C.	72 h.	Kolmer	1942
Serum exudate from chancre, R.T.	121 d.	Lacy	1921
10% rabbit serum, -20 C.	2 mos.	McLeod	1949
Frozen plasma, -78 C.	3 yrs.	Ravitch	1942
Blood, ice box.	96 h. non-infectious	Ravitch	1949
Plasma, -20 C.	>48 h., non- "	"	
Rabbit plasma, 5 C.	6 d.	Selbie	1943
Blood of G.P., 14 C.	2-33 d.	Sergent	1938
" " 20 C.	33-60 d.	"	
" " 0 C.	7-8 wks.	"	
" " 10 C.	1 d.	"	
Citrated whole blood, 5 C.	72 h.	Turner	1941
Plasma, 5 C.	62 h.	"	
Human serum, physiol. saline under vaseline, R.T.	5 d.	Zurhelle	1927
In organ parts, R.T.	3 d., 17 hrs.	"	
FECES			
Borrelia spp.			
Feces	4 wks.	Gowen	1945
L. icterohemorrhagica			
Feces	24 h.	Noguchi	1918
Urine, Body temp.	wks. or mos.	Sawers	1938
~~URINE~~			
L. icterohemorrhagica			
R.T.	Still infectious 2 d.	Uhlenhuth	1916

TABLE B2 THE SURVIVAL OF BORRELIA, LEPTOSPIRA, SPIRILLUM AND TREPONEMA SPECIES IN THE BODY. (CON'T) (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
TISSUES, GENERAL			
B. duttoni			
Mouse tissue, -78 C.	1 mo.	Oag	1939
Frozen rabbit testes, -78C.	1 yr.	Turner	1939
L. icterohemorrhagica			
Infected G.P. liver in ice	26 d.	Buchanan	1927
Whole pig liver blocks, -20 C., frozen	Viable & virulent 100 d.	Stravitsky	1945
Whole pig liver blocks, lyophilized	0	"	
Frozen rabbit testes, -78C.	10 mos.	Turner	1939
Decomposing liver, R.T.	27 hrs.	Uhlenhuth	1916
Infected liver, R.T.	3 d.	"	
Infected G.P. liver, ice	26 d.	"	
Treponema pallidum			
Dead autopsy tissue, 5 C.	3-5 days after death	Armuzzi	1926
Rabbit testis, heavy susp.	72 hrs.	Block	1941
Citrated rabbit blood, 3.5 C., mixed with testis	96 hrs.	"	
Testicular in vitro extract,			
39 C.	5 hrs.	Boak	1932
40 C.	3 hrs.	"	
41 C.	2 hrs.	"	
41.5 C.	1 hr.	"	
Dead bodies of cong. syphilitic children, refrig.	24-36 h.	Hoffman	1926
Rabbit testes dried in vacuo from frozen state	nil.	Hampp	1951
Corpse of cong. syphilitic child	5 d.	Koch	1911
Corpse of " " child, dried & incub. 37C.	Recov. 0 72 hrs.	Kratzeisen	1923
Liver & sterilized gall.	Recov. 0 72 hrs.	"	
Liver with bouillon.	" "		
Liver with NaCl	" "	"	
Liver with	" "	"	
Human autopsy material. Ice box	48 hrs.	Lacy	1921
Chancre	7 d.	"	
Saline susp., rabbit testicle, R.T.	58 d.	"	
Rabbit testicle, ice box.	58 d.	"	
Rabbit testes, 5 C.	Recov. in 3 d.	Levaditi	1946
Autopsy mat'l. from syphilitic patients, 5 C.	Recov. in 3 d.	"	
Susp. rabbit testes, -78 C.	1 yr.	McLeod	1949
Tissue susp., 37 C.	24 h.	Miyao	1930
Syphilitic mat'l. 10 C.	3 h.	Neisser	1911
" " ice chest	24 h.	"	
" " 48 C.	30 min.	"	
Tissue susp., 0 C.	2 h.	Miyao	1930
Autopsy mat'l. in ice box.	7 d.	Rosahn	1935
Rabbit testes	10 d.	Perry	1948

TABLE 82 THE SURVIVAL OF BORRELIA, LEPTOSPIRA, SPIRILLUM AND TREPONEMA SPECIES IN THE BODY (CON'T). (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
TISSUES, GENERAL, CON'T.			
Treponema pallidum			
Frozen exudates	13 mos.	Shmuntoff	1949
Testicular extracts, -10 C.	< 2 mos.	Turner	1938
" " -20 C.	"	"	
" " -78 C.	1 yr.	"	
Testes of rabbit, -78 C.	3 yrs.	Turner	1939
Excised chancre, R.T.			
Dried in vacuum	68 hrs. to 4 d.	Zurhelle	1927
T. pertenue			
37 C., tissue susp.	2 h.	Miyao	1930
Testicular extracts, -78 C.	1 yr.	Turner	1938
Testes of rabbits, -78 C.	3 yrs.	Turner	1939

TABLE B9 THE SURVIVAL OF BRUCELLA SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference
BLOOD		
B. abortus		
Sterile rabbit blood susp	At least 5 yrs.	Frobisher 1947
B. bronchiseptica		
Sterile rabbit blood susp	9 yrs.	"
Broth culture, 0 C.	43 d.	Hampil 1932
B. melitensis		
Sterile rabbit blood susp.	3 mos.	Frobisher 1947
Normal skin of G.P. more vulnerable to B. melitensis entry than digestive tract.		Hardy 1929
B. spp		
Citrated 4C. from convalescing patient.	6 mos.	Spink 1950
B. suis		
Sterile rabbit blood susp.	3 mos.	Frobisher 1947
FECES		
B. abortus		
Isolated from patient's stool in 10% CO_2, aerobically and anaerobically.	Surviving in 16th month of infection.	Amoss 1929
B. melitensis		
Dry, sterile manured soil	72 d.	Horrocks 1906
moist, sterile " "	7 d.	"
" unsterile " "	20 d.	"
B. suis		
Feces, sterile, dark.	100 d.	Anonymous 1933
" " "	100 d.	Cameron 1933
SKIN		
B. melitensis		
34% inhibited on normal human skin	--	Hill 1933
URINE		
B. melitensis		
Favorable conditions	6 d.	Bang 1894
Urine contam. with dust.	30 d.	Chief 1944
TISSUES, GENERAL		
B. abortus		
Uterus of cow, F.P.	9 mos.	Bang 1897
Uterine exudate "	7 mos.	"
Hog, lymph nodes.	Found in packing house	McCullough 1949
Dogs fed aborted fetus, placenta & lymph nodes.	Virulent 151 d.	Morse 1951
B. melitensis		
Uterus, F.P.	6 d.	Bang 1897
Colon at autopsy	More prevalent in cold wet season than dry & hot.	Eyre 1908
B. suis		
37-39 C., In vivo	Did not persist for prolonged periods.	Braun 1951
Hog tissue, -10 F.	Still viable, 30 d.	Huddleson 1933
Spleen	Recov. small #., 40 d.	"
Swine tissue, -10 F.	Recov. good %, 40 d.	"
Spleen, 40 F.	45 d.	"

TABLE B4 THE SURVIVAL OF CLOSTRIDIUM, CORYNEBACTERIUM, HEMOPHILUS, LACTOBACILLUS, MALLEOMYCES, MICROBACTERIUM, PROTEUS, PSEUDOMONAS, SERRATIA & ERYSIPELOTHRIX IN THE BODY. ~~(AND BODY MATERIALS)~~

Factor(s)	Survival	References	
BLOOD			
Clostridium tetani			
Free spores from animals dying of tetanus. Inject subcutaneously	Recov. up to 17th d.	Canfora	1907
May remain dormant at site of injection for as long as 4 mos.		Francis	1914
Corynebacterium pseudotuberculosis (Preisz-Nocard)			
Horse serum in flask, light	11 mos.	Urbain	1930
" " " dark	13 mos.	"	
" " test tube, light	1 mo.	"	
" " " dark	11½ mos.	"	
Corynebacterium diphtheriae			
Washed, dried in sunlight (serum)	121 d.	Abel	1893
Sterile rabbit blood susp.	Hundreds of strains survived 13 yrs.	Frobisher	1947
Hemophilus influenzae			
Sterile rabbit blood susp.	6 wks. or less	Frobisher	1947
Blood broth, -15 C.	2½ hrs.	Hampil	1932
" -20 C.	1½ hrs.	"	
Hemophilus pertussis			
Sterile rabbit blood susp.	6 wks. or less	Frobisher	1947
Lactobacillus acidophilus			
Sterile rabbit blood susp.	At least 5 yrs.	Frobisher	1947
Microbacterium, spp.			
Sterile rabbit blood susp.	5 yrs.	"	
Proteus spp.			
Sterile rabbit blood susp.	3-9 yrs.	"	
Pseudomonas spp.			
Sterile rabbit blood susp.	5 yrs.	"	
FECES			
Cl. botulinum			
Feces	No survival	Burke	1919
"	No survival in human & animal following ingestion	Easton	1924
Cl. tetani			
Dog feces	16 d.	Sormani	1891
Malleomyces pseudomallei			
26-27 C., culture	27 d.	Fletcher	1928
1% phenol, 37 C.	24 h.	"	
1% formalin, 40 C.	24 h.	"	
SKIN			
Proteus spp.			
Proteus species survived longer on skin than on filter paper		Hellat	1948
1.6% inhibited on normal skin		Hill	1933
Pseudomonas aeruginosa			
Survived longer on skin than on filter paper		Hellat	1948
4.4% inhibited on normal skin		Hill	1933

TABLE R4 THE SURVIVAL OF CLOSTRIDIUM, CORYNEBACTERIUM, HEMOPHILUS, LACTO[illegible], MALLEOMYCES, MICROBACTERIUM, PROTEUS, PSEUDOMONAS, SERRATIA [illegible] ERYSIPELOTHRIX IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SKIN (CONT.)			
Serratia marcescens			
Skin or arm, cult. dil. 1:1,000, dry	Inoc. 718, Recov. 94 after 5 min.	Arnold	1934
Skin, cult. dil. 1:1,000 moist	Inoc. 696, Recov. 151 after 5 min.	"	
Skin of back, not washed	Inoc. 1,000, Recov. 1 after 30 min.	Arnold	1930
Skin, body temp., dirty or fatty.	Recov. 0, 30 min.	"	
Skin, 37 C., before drying	Inoc. 34,000, Recov. 0 in 15 min.	Bryan	1933
Skin, 37 C., after drying	Inoc. 51,000, Recov. 0 in 10 min.	"	
Sterile rabbit blood susp.	At least 5 yrs.	Brobisher	1947
Survived longer on skin than on filter paper		Hellat	1948
16.1% inhibited on normal skin		Hill	1933
Palmar surface, clean hand	Inoc. 1,200, Recov. 0 after 2 min.	Norton	1932
Washed hide	Inoc. 520, Recov 0., after 20 min.	"	
Palms of hands.	Inoc. 1,200, Recov. 112, after 1 min.	"	
Kept moist by water vapor	Inoc. 920, Recov. 1,000 after 30 min	Norton	1931
Dry surface of skin	Inoc. 770, Recov. 900, after 70 min.	"	
Skin of forearm	0-40 min.	"	
Skin, moist with water vapor.	Inoc. 310, Recov. 150, 30 min.	"	
Unwashed tanned hide, dry.	Inoc. 3,000, Survive 4 hrs. 15 min.	"	
Washed tanned hide, dry.	Inoc. 2,440, Survive 1 h. 20 min.	"	
Dirty or fatty skin	Several hrs.	Singer	1929
URINE			
Malleomyces pseudomallei			
26-27 C., culture	16 d.	Fletcher	1928
TISSUES, GENERAL			
Clostridium botulinum			
Intestinal tract, 22 C.	4 mos.	Burke	1919
Cl. sporogenes			
War wounds.	5 yrs.	Anonymous	1923
Cl. tertius			
War wounds.	5 yrs.	"	
Cl. tetani			
Liver, spleen, bone marrow, lungs, lymph glands. Free spores from dying animals.	Recov. up to 55 d.	Canfora	1907
Kidney, spleen	Found at site of inoculation after 26 hrs.	Koser	1917

TABLE B4 THE SURVIVAL OF CLOSTRIDIUM, CORYNEBACTERIUM, HEMOPHILUS, LACTOBACILLUS, MALLEOMYCES, MICROBACTERIUM, PROTEUS, PSEUDOMONAS, SERRATIA & ERYSIPELOTHRIX IN THE BODY. (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
TISSUES, GENERAL (CONT.)			
Cl. tetani			
Horse intestine	4 mos.	Noble	1915
Fresh G.P. feces	16 d.	"	
Remain viable at site of inoculation	6 mos.	Semple	1911
Recovered from liver, spleen kidney, lungs & bone marrow following subcut. inject.	11d to 3½ mos.	Tarozzi	1906
Corynebacterium diphtheriae			
Small dried pieces	9 wks.	Abel	1893
Inoc. on membrane	4 mos.	"	
Throat of boy after attack	Virulent 6 mos.	Macgreggor	1898
Erysipelothrix rhusiopathiae			
Dried, dark	1 mo.	Hull	1947
Sunlight	10 12 d.	"	
Salted or pickled meat	3 4 mos.	"	
Carcass of buried animals	mos.	Losn[illegible]	189[illegible]
Erysipelothrix spp.			
18-20 C., carcass	mos	Hettche	193[illegible]
Serratia marcescens			
Mouth, 28 S.	16 h.	Teague	1912

TABLE B5 THE SURVIVAL OF DIPLOCOCCUS PNEUMONIAE IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
R.T., sealed tubes, dark	--------	Arkharow	1892
Broth, saliva, or 0.5% saline susp'n, R.H. 40-55%, Type I	Very high mortality rate	Dunklin	1948
Broth, saliva, or 0.5% saline susp'n, R.H. above or below 50%, Type I	Long periods		
Inject into g.p., 37C.	65 1/2 hrs.	Emmerich	1894
Sterile rabbit blood susp'n	5 of 8 strains--5yrs. 11 strains, 9 yrs.	Frobischer	1947
Fluid, defibrinated blood	2 mos.	Gilbert	1896
Rabbit blood dried, 80F, glass & gauze, light & dark, Type II(smooth)	2 mos.	Stillman	1940
40F., in ice box, dark, glass & gauze, Type II (smooth)	12 mos.	"	"
80F., on glass, daylight, dried, Type I	1 mo.	"	"
80 F., on glass, dark, dried Type I	2 mos.		
40F. in icebox dark, Type I glass;	12 mos.	"	"
gauze	9 mos.		
80F. daylight, glass & gauze, Type III(smooth)	5 mos.		
80F. dark, glass, Type III	7 mos.	"	"
80F. dark, gauze, Type III	11 mos.		
40F., dark, icebox glass	13 mos (Type III)		
40F. dark, icebox, gauze	12 mos. " "	"	"
SPUTUM			
37C., with dust, air dried	Recov. 0 in 25 das	Germano	1897
37C, dried	4mos.	Guarnieri	1888
Dried in test tubes, 80F., diffuse daylight, TypeIII	20 wks	Stillman	1940
Dried, ice box, 40F, dark	40 wks.		
Dried, Type I	4 wks.	"	"
Dried sputum, dark; diffuse light	35 days 30 days	Wood	1905
Moist sputum, 22 C., dark; 0 C., dark	11 days 35 days		
Moist sputum, 22C., strong light	25 days	"	"
Dried, sunlight	24 hrs.		
Powdered, dark	1-4 hrs.	"	"
Powdered, sunlight	1 hr.		
Sprayed	24 hrs.		
Moist sputum	12 wks		
Dried, dark	35 days	"	"
diffuse light	30 days		
GENERAL			
32-35 C. Abdominal cavity	4-5 days	Foa	1888

TABLE B6 THE SURVIVAL OF ESCHERICHIA COLI, AEROBACTER AND PARACOLOBACTRUM IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
Normal rabbit serum, drying	Death rate logarithmic so that it is proportional to conc. of surviving bacteria.	Chick	1912
M.O. added to normal rabbit serum.	Living bact. remain stationery.	"	"
FECES			
Cow feces	2-3 hrs.	Cohn	1950
Fl. stool, R.T., dark	>55 days	Dold	1944
Stool, dried on filter paper, R.T., dark	>45 days		
Watery stool, R.T., dark	>143 days	"	"
Thin watery stool dried on filter paper	>143 days		
Fluid stool, R.T., dark	6 mos.		
Fl. stool, dried on filter paper, R.T., dark	Recov. pure cult. >8 mos.	"	"
Fl. stool. R.T. dark	>5 mos, 16 days		
Stool, dried on filter paper, dark, R.T.	2 mos, 21 days		
Fl. stool in dark, R.T.	>3 mos. 19 days	"	"
Dried stool in dark, R.T.	71 days		
Fl. stool in dark, R.T.	1 mo.		
Dried stool in dark, R.T.	1 mo.		
Fl. stool, dark, R.T.	>54 days		
Dried stool, dark, R.T.	>54 days	"	"
Fecal susp'n., 20 C.	8 weeks	Jordan	1926
37 C.	20 days		
10 C.	22 weeks		
-11 C.	18 weeks		
R.T.	2 mos.		
Feces, -8 F to -30 F., exposed to open air.	>100 days	Lu-Ti-Huan	1930
Fecal emulsion, dilute,			
diffuse sunlight	3 days	Mc Naught	1910
inside window	11 days		
test tube, direct sunlight	19 hrs.		
Feces, saline susp'n., 37 C.	<3 mos	Parr	1937
Feces, saline susp'n., ice-box temp.	599 days		
Feces, 37 C.	1 yr. 8 mos.		
Feces 40 C.	2 yrs.		
Feces, -11 C.	2-3 mos.	"	"
Feces, ice-box temp.	359 days		
Feces, animal, 61 F., inoc. 1-3 thos. 52 F.	Recovered 3-10 in 4 wks.	Savage	1917
Feces, on stump, blizzard			
inoc. 512,000/gm.;	Recovered none, 18 das.	Tonney	1931
on stump, spring, inoc. 11,800/ gm.;	Recovered none, 153 das.		
on stump, warm season;	172 days		
pure cult, stump, winter, inoc. 323,000/ gm.	Recovered none, 22 das.	"	"

TABLE 36 (CONT'D) THE SURVIVAL OF ESCHERICHIA COLI, AEROBACTER AND PARACOLOBACTRUM IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SKIN			
Palmar surface, clean, inoc. 4,000	Recovered 1 after 10 min	Arnold	1930
Skin, body temp. dirty or fatty.	Several hours		
Skin, palmar surface, clean, hand, body temp.	Recovered 0 after 10 min		
Skin, 37 C., inoc. 78,000	Recovered 0 after 10 min	Bryan	1933
Wiping hand with towel		Grubb	1947
Survived longer on skin than on filter paper		Hellot	1948
33% inhibited on normal human skin		Hill	1933
Palm of hand	Entirely destroyed in 10 min.	Krueger	1942
Skin, desiccation, high R.H., 99%, 96 F.	8 hrs. 2 wks	Rebell	1950
URINE			
Exposed to open air, -8 F to -30 F.	>100 days	Lu-Ti-Huan	1930
GENERAL			
Stomach-absence of free HCl.	Coliforms found in abundance	Lohr	1927
Isolated from frozen shrimp more frequently than any other coliform organism.		Holmes	1949
FECES			
Aerobacter aerogenes			
Crude, dil. 1/100,000	Not given	Atkinson	1934
Sterile rabbit blood susp.	3-9 yrs.	Frobisher	1947
Found by many workers in human feces		Gray	1932
Fresh, R.T.	16 d.	Jordan	1926
Pure cult. on stump during blizzard in winter	9 d.	Tonney	1931
SKIN			
Aerobacter aerogenes			
5% inhibited on normal human skin		Hill	1933
BLOOD			
Paracolobactrum aerogenes			
Sterile rabbit blood susp.	3-9 yrs.	Frobisher	1947

TABLE B7 THE SURVIVAL OF METAZOA AND PROTOZOA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
Anaplasmosis (Bartonella bovis)			
Dried blood	<3 das	Dypstra	1948
Blood submitted to heating and chilling over period of 6 das.	0		
Plasmodium vivax			
-50 to -70 C.	10-15 das	Saunders	1947
Tryponosoma equiperdum			
Bats kept at low temp.			
10 C to 3-4 C.	Do not develop	Kalabuchov	1935
33 C. to 37 C.	Develop in blood in short time		
FECES			
Entamoeba histolytica			
Feces 37 C.	2-4 hrs.	Gurevitch	1947
Feces, 25-30 C.	5-8 hrs.		
Feces, 6-8 C.	8-10 hrs.		
Infected feces, 27-30C.	9 das.	Kuenen	1913
37 C.	3 das.		
Infected feces, with Icc salt mixture, freezing. inoc. 50 cysts	Recov. 13 dead fbisome hrs.		
Stool emulsion, R.T., allowed to dry on fingers	10 min.	Spector	1934
Dried feces	Instant death	Wenyan	1917
Very dilute feces	> 1 mo.		
Feces with free Cl_2 in water, 1:10,000	No effect in several hrs.		
0 C., 16 hr. cult.	9 das.	York	1926
16-20 C.	7 das.		
0 C. washed & conc. cysts	17 das.		
16-20 C., washed & conc. suspension.	10 das.		
Human feces, cult. tube	14 das.	Dobell	1936
R.T. 4 hrs., and 14 C. for 14 hrs.	2 das.	Beaver	1949
Soil plus stool plus water R.T., 1 hr	6 das.		
14C. 12 hrs.	4 das.		
28-34 C.	8 and 4 days.	"	"
Feces	3 das.	Rudolfs	1951
Entamoeba coli			
Human feces, 1-2C., culture cysts	4 1/2 mos.	Dobell	1936
Stool emulsion, R.T., allowed to dry on fingers	More resistant than E. histolytica	Spector	1934
Entamoeba coli marcorcarum			
Monkey feces, naturally infected	4 1/2 yrs.	Dobell	1936

TABLE B7 (CONT'D) THE SURVIVAL OF METAZOA AND PROTOZOA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
FECES (CONT'D)			
Hookworm			
Night soil, dil. with urine, summer temp.	99% killed, 2-3 wks.	Cort	1925
Night soil dil. with urine, summer temp.	99% killed, 2-3 wks.	Cort	1926
Human feces, direct sunlight	Lethal even in moist tropics	Faust	1924
Moist feces, lab. temp.	13 mos.	Galli	1905
Water, moist feces, larvae	7 mos.	Leichtenstern	1887
Fecal mat'l in abandoned latrine in brickyard	3 mos.		
60 F., strong sunlight	>2 hrs (larvae)	Nicoll	1917
Strong sunlight under glass	1 hr.		
Necator americanus			
45 C.	2 hrs.	Nicholls	1939
Ascaris lumbricoides			
Human feces on sand in sun, ova	21 days	Brown	1927
Human feces on sand in shade	Recov. 90.8%, 35 das.		
Clay in sun	71% motile, 21 das.		
Clay in shade	85% motile, 21 das		
Loam in shade	89.3% motile, 21 das.		
Human feces, in shade	72-92% motile, 4 wks.	Caldwell	1928
Pig feces, in shade	99% motile, 4 wks.		
Human feces, drying in sunlight, 130 F.	35-40 % disintegrated > 7 1/2 hrs.		
Pig feces, sunlight, 130F	5-30% disintegrated in >7 1/2 hrs.	"	"
Human and pig feces, lying shade	Recov. 0, 2 wks.		
Human feces moist with constant temp. 40-50C.	38% ova disintegrated in 14 das.	"	"
Pig feces, moist with constant temp. 40-50 C.	40% ova disintegrated in 14 das.	"	"
45 C. compost	3 mos.	Nicholls	1939
54-55 C.	3-5 min.	Nolf	1932
Fecal susp'n of eggs	All degenerate in 27-35 das.	Rudolfs	1951
Trichuris trichuris			
Human feces, 30 C. on cover slip, incubator, moisture, sat'd, inoc. 1000	Recovered 0, 29 das.	Nolf	1932
-12 C., 4 das. incubation before exposure	6 das.		
-9 C., 4 das incubation	Recovered 40%, 8 das.		
Sand in shade, human	74% motile, 35 das.	Brown	1927
Eggs of T. trichiura, as well as N. americanus, A. lumbricoides, T. saginata, S. haematobium, pass thru cockroach unharmed.		Macfie	1922

TABLE 87 (CONT'D) THE SURVIVAL OF METAZOA AND PROTOZOA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
URINE			
A. lumbricoides			
Human urine	No survival	Yoshida	1920
Trichomonas vaginalis			
Urine, 20C., inoc. with vaginal secretion	Few alive in 20 hrs.	Jirovec	1948
GENERAL			
T. vaginalis			
Vaginal discharge	Recov. 2-4% in 6 hrs.	Kessel	1950
Vaginal discharge, R.T., Paraffin sealed cover-slips.	>5 das.	Kirby	1943
Pus, dry	3 hrs.	Swift.	1937
E. histolytica			
Cysts drying on human hand	5 min.	Spector	1934
Cysts pass through cockroach	unharmed	Macfie	1922
T. batrachorum			
In Riana pipiens, R.T., distilled water, and gastric mucin	6 yrs & 11 mos.	Wenrich	1949
T. wenyani			
In white rats, R.T., with distilled water and gastric mucin.	4 yrs.	"	"
In amphiuma, R.T., with gastric mucin	4 yrs.(T. prowazeki)	"	"
T. augusta			
In Rana pipiens, R.T., with water & gastric mucin.	2 yrs.	"	"
T. hominis			
In man, 32-34 C., in water and gastric mucin.	3 yrs.	"	"
T. species			
From Crotelus horridus	2 yrs.	"	"
Trivitus parva			
From Triturus viridescens	4 yrs.	"	"
Monocercomonoides			
From Lipulid larvae	4 yrs.	"	"
T. spp.			
From Japanese beetle larvae.	4 yrs.	"	"
Trichinella spiralis			
G.p., rat muscle, pork, pork sausage, -35 C.	2 Hrs.	Blair	1934
-17.8C.	53 hrs.		
Tr. spp.(larvae)			
Pork, -27C.	36 hrs.	Gould	1949
-30C.	24 hrs.		
-33C.	10 hrs.		
-35 C.	40 min.	"	"
-37C.	2 min.		

TABLE 88 THE SURVIVAL OF MOLDS, YEASTS & FUNGI IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SKIN			
M. oudouini			
Hair	420 d	Farley	1921
Hair in well stoppered bottles	125 d	Robinson	1948
Trichophyton interdigitale			
Scrapings from toes	300 d	Mitchell	1922
SPUTUM			
Coccidioides immitis			
Sputum, sun with earth	Vegetative form, 30 d Parasitic stage, 240 d	Rosenthal	1950

TABLE 39 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
M. tuberculosis			
Saline soln., R.T.	10 weeks	Coulthard	1951
In arachis oil	10 weeks		
In saline and arachis oil	At least 26 weeks		
Human whole blood	14 days	Davies	1939
Hemoglobin inhibits the growth of the tubercle bacillus. Effects proportional to conc. of hemoglobin.			
FECES			
M. tuberculosis			
Feces, R.T., dark, summer	1 day	Abe	1949
fall	3 days		
winter	9 days		
Feces, 8 C.	Still virulent, 3 1/2 mo	Gärtner	1898
Dung	Virulent tubercle bacillus remained after 178 days	Maddock	1933
Feces, No. of M.O. in feces proportional to those of sputums		Nüssel	1923
Feces, cool, stored in jars with loose lids, natural infected	12 mos.	Stenhause	1930
Feces, cellar, dark, with muslin to exclude insects artifically infected	2 years		
Liquid manure	4 mos.		
Liquid manure, winter, artifically infected	5 mos.		
spring	2 mos.		
fall	4 mos.	"	"
autumn	4 1/2 mos.		
Cow feces, exposed on pastureland, winter	5 mos.	"	"
spring	2 mos.		
autumn	4 mos.		
summer	2 mos.		
Cow feces, protected from sunlight, summer	4 mos.	"	"
autumn	6 mos.		
M. paratuberculosis			
Infected feces, atmospheric conditions	246 days	Lovell	1944
PUS			
M. tuberculosis			
Pus, room temp., dark	Viable 4 mos.	Abe	1949
Pus, R.T., in half dark	Viable 3 mos.		
SKIN			
M. tuberculosis			
Human tubercle bacillus in reed capsule placed under skin of cattle	7 years	Heymans	1927

TABLE 57 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SPUTUM			
M. tuberculosis			
Sputum, R.T., dark	Viable 4 mos.	Abe	1949
Sputum, half dark	Viable 3 mos.		
Sputum, 37 C.	Persistence time 10 das. recovery time 0	"	"
Sputum, direct sunlight			
summer	50-80 min.	"	"
fall	60-110 min.		
winter	90-240 min.		
Sputum, diffuse light			
summer	8 days	"	"
fall	7 days		
winter	5 days		
On window of room			
spring	13 days	"	"
fall	18 days		
summer	20 days		
Sputum, exposed to sunlight, 12-14 C, R.H.50%,			
afternoon	9 min, recovery 12≠	Albini	1940
noon	1-4 min.		
diluted 1:2(5:00 PM.)	1 min., recovery 3 ≠		
diluted 1:25	----------------		
Sputum, exposed to sunlight, 7-9C., R.H. 40%			
afternoon	1 min., recovery 3 ≠	"	"
diluted 1:2	4 min., recovery ≠		
diluted 1:25	------------------		
Sputum, 43-35 C. R.H, 40%	------------------	"	"
Sputum, dried, surface of wooden tongue blade	Infective for g.p. 4 - 18 weeks	Arms	1912
Dried or moist	No viable after 3 yrs.	Burns	1917
Mixed with dust and exposed to sunlight up to 72 hrs.	Viable when inject. into g.p. 2-72 hrs.	Caldwell	1925
Droplets, 15-20 C	30-40 days	Chausse	1912
Droplets, 10-15 C.	50 days		
Direct sunlight	Few mins. to few hrs.	Cornet	
Diffuse sunlight	Several days		
Dried in layers not too thin.	Several mos. to 1 yr.	"	
Desiccated, 30-40 C.	9-10 mos.	De Thomas	1886
Sputum	6 mos.	Cornet	1904
Droplets from speaking or coughing, 45 C.	300-600 times increase in count	Flügge	1921
Loud speaking, droplets 45 C.	30 min.		
Drops from bronchial tree	----------------------	"	"
Dried sputum	Several months	Harder	1913
Coughed on paper, stored in bell jar, dried 24 hr.	>50% infect. in 2 das., none infect in 31 das.	Kenwood	1915

TABLE 37 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SPUTUM(CONT'D)			
<u>M. tuberculosis</u>			
Droplets,	4-7 days	Kirstein	1905
Desiccated	Several mos.	Koch	1882
Alternately dried and moistened	12 days	Malassez	1883
Sunlight	Few minutes to 48 hrs.	Mayer	1924
Ultra-violet lamp for 3 min. at distance of 5".	Required 25 min. to destroy all organisms	"	"
Thin layer, dried	Still virulent, 30 min.	Migneco	1895
Direct sunlight	None recovered, 24-30 hrs.		
Dried in sun	18 hrs.		
Exposed to light and air in June & July	<45 days	Ransom	----
Little or no air and dark	16 days		
Dried 24 hrs., dark	>1 day		
Dried 24 hrs, dark, exposed to little air	>35 days	"	
Dried sputum	179 days	Schill	1884
Desiccated	Several months		
Direct north roomlight, 45-76 F., R.H. 17-62%	4 hrs. to 5 days	Smith	1942
Direct north roomlight, darkness	9 das. to 5 mos.		
45 F., R.H. 17-62% , dark	6 1/2 - 14 mos.	"	"
70F., 83% R.H., dark, cover slip	142 days		
63 F., 77% R.H., dark, water susp'n.	15 days	"	"
72F., 79% R.H. dark	18 days		
In India, direct sunlight	6-8 days	Soparkar	1917
Dessicated in dark	309 days		
Direct sunlight	6-8 hrs.		
Decomposing sput., test tube	20-26 days	"	"
Dried in thin smears	4 mos.	Sormani	1886
Dried sputum	10 mos.		
Fluid sputum	8-11 days	Toma	1886
Dark, moist box in pariffined bottles	Produce lesion in 170 das. Produce no lesion in 188 das.	Twichell	1905
Dark closet	Lesion in 160 das, no lesion in 188 days.	"	"
Dark moist box, bottle stoppered with cotton	Lesion in 157 das., no lesion in 172 days.		
Diffuse light, ordinary room, paraffined bottle	Lesion 124 days, no lesion in 175 days	"	"
In ice	Lesion in 102 days, no lesion in 153 days		
Dark closet, bottles stoppered with cotton	Lesion in 100 das, no lesion in 141 days		
Moist, light place in sand	Lesion in 123 das, no lesion in 148 days.	"	"

TABLE B9 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SPUTUM			
M. tuberculosis			
Out of doors, winter mos. open bottles	Lesion in 110 das, no lesion in 132 das.	Twichell	1905
Handerchief	Lesion in 70 das, no lesion in 110 das	"	"
Woolen blanket	Lesion in 70 das, no lesion in 110 das.		
Wood	Lesion in 70 das, no lesion in 110 das,	"	"
In thermostat	Lesion in 33 das., no lesion in 70 das.		
Dry light place, sand	Lesion 30 das., no lesion 70 das.	"	"
Carpet	Lesion in 39 das, no lesion in 70 das.		
Direct sun	Lesion in 1 hr. , no lesion in 7 hrs.	"	"
Dried, R.T.	Infective 70 days	Twichell	1906
Dried on carpet	Infective 39 days		
20 C., dark	4 mos.	Vidal	1934
2 C.	12 mos.		
Dried	Several weeks	Villemin	1869
M. paratuberculosis			
Electric light	74-100 days	Soparkar	1917
Direct sunlight	10-12 hrs.		
Diffuse light	30 days		
Diffuse daylight	6-8 days	"	"
URINE			
M. tuberculosis			
Room temperature, dark;	Viable 4 mos.	Abe	1949
in half dark	Viable 3 mos.		
2-3 C.	Viable [illegible]		
60 C.	Recovered 0 in 1.5 hrs.	Nasta	1930
Refrigerator	Recovered 0 in 30 days		
Inject into peritoneum of g.p.	Lose power in 30-40 das.	"	"
GENERAL			
M. tuberculosis			
Dried or broken up organic matter	Still virulent at 43 & 38 das. respectively	Cadeac	1888
Pieces of lung -1 to -8C. exterior windowsill	< one week		
Lung tissue inoc. and buried	167 days		
Bacilli remain in phthisical cadavers for several years		Calmette	1920
Distilled water, 37 C.	< 1 day	Davies	1939
0.9% saline, 37 C.	< 4 days		
Lung of rabbit, .80 meter underground	> 23 days	Galtier	1887
In bile	Growth more rapid than in soap	Larson	1922

TABLE B9 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
GENERAL (CONT'D)			
M. tuberculosis			
Rabbit tissue, buried in zinc box	3 mos. 6 das	Petri	1921
Buried lung	2 1/2 yrs.	Schottelius	1890
Intestinal contents, cow, not infect., autumn	4 mos.	Stillman	1938
summer	2 mos.		
Lung	3 years	Stone	1891
Rabbit lung, liver, spleen kidney, 20 C., sterile, in vitro	5 days.	Vidal	1934
Rabbit tissue, 2 C.	10-30 days		
Lymph node emulsion in incubator in salt soln.	87 days	Webb	1921
Lymph nodes coated with collodion	7 days		
Liver and spleen coated with collodion	3 wks.		
Rabbit lung	14 mos. per rabbit following exposure to air	Wells	1941
Dead buried fowls	At least 1 yr.	Schalk	1928
M. paratuberculosis			
Intestinal scrapings mixed with river water, outdoor temp.	Recovered in 163 das.	Lovell	1944
B.C.G.			
Spleen of g.p.	53 days	Gernz-Rieux	1950
Axillary lymph nodes	175 days		

TABLE B/10

THE SURVIVAL OF MICROCOCCUS SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
M. spp.			
Sterile rabbit blood suspn	24 strains viable 9 yrs. 15 strains viable 19 yrs	Frobisher	1947
FECES			
M. pyogenes var. aureus			
Feces, sunlight with heat	Bactericidal effect not marked	Lehmann	1931
SKIN			
M. pyogenes var. aureus			
Skin, 37 C., inoc. 161,000	Recov. 34,000 in 15 min.	Bryan	1933
Skin, left palm, expose m.o. 8 min., inoc.2568	Washed off 1414	Burtenshaw	1938
Dead skin, expose 10 min. inoc. 2568	Washed off 1560		
Skin, inframammary fold, down	80% recov. in 1 hr.	Cornbleet	1932
up	20% recov. in 1 hr.		
Skin, axilla , arm up;	32 % recov. in 30 min.		
arm down	61% recov. in 30 min.	"	"
Interdig. spaces of toes, together;	73% in 30 min.		
apart	24 % in 30 min.	"	"
Perianal fold, closed;	76% recov. in 30 min		
open	28 % recov. in 30 min		
Palms, clasped;	53% recov. in 30 min.		
open	6 % recov. in 30 min.	"	"
Growth in sweat of skin	Alkaline areas slower than acid in self steri-lizing action	"	"
Nail beds and areas sur-rounding nail beds	Less effective at steri-lizing than normal areas	"	"
Keratotic areas	No more effective at re-moving M. aureus than normal areas	"	"
Moist areas	Depression of steriliz ing power		
Denuded epithelium	Not as effective in re-moving Staph. as intact areas.	"	"
Previous exposure to U.V.	Does not enhance des-tructive power against Staph.	"	"
Skin of persons with fur-unculosis	Remain longer than in skin of others	"	"
Psoriatic lesions, bared of scales	Free themselves of Staph faster than lesions with scales.	"	"
Survived longer on skin than on filter paper		Mellot	1948
17.2% inhibited on normal	skin	Hill	1933

TABLE B/0 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SKIN (CONT'D)			
M. pyogenes var. aureus			
Washed hide, inoc. 900	Recov. 360 in 30 min.	Norton	1932
Washed hide, inoc. 1,000	Recov. 25 in 20 min.		
Wounds	Recov. in 18 of 82 wound	Rountree	1947
Dirty or fatty skin	Several hours	Singer	1929
SPUTUM			
M. pyogenes var. aureus			
Increased survival time dried sputum		Bordoni	1891
GENERAL			
M. pyogenes var. aureus			
Body temp.	Recovery 0	Arnold	1930
Pus, R.T.	2 1/2-3 1/2 years. none of pathogenicity lost	Bormann	1940
Exposed to long chain fatty acids	Lethal	Burtenshaw	1945
Pus, sunlight & heat	Bactercidal effect not marked	Lehmann	1931
Boils, 11 strains,			
pH 2.6	8 viable at 24 hrs.	Hall	1921
pH 5.0	3 viable at 24 hrs.		
pH 10.0	10 viable at 24 hrs.		
Boils, 11 strains,			
pH 2.6	10 viable at 7 days	"	"
pH 5.0	1 viable at 7 days		
pH 8.0	1 viable at 7 days		
pH 10.0	10 viable at 7 days		
Abscesses, 4 strains			
pH 2.6	2 viable at 24 hrs.	"	"
pH 5.0	2 viable at 24 hrs.		
pH 8.0	0 viable at 24 hrs.		
pH 10.0	1 viable at 24 hrs.		
Abscesses, 4 strains			
pH 2.6	2 viable at 7 days	"	"
pH 5.0	2 viable at 7 days		
pH 8.0	0 viable at 7 days		
pH 10.0	1 viable at 7 days.		
Spinal fluid showed various pH ranges		"	"
M. pyogenes var. albus			
Sputum, antrum nose, skin, throat, urine and uterus showed various pH ranges		"	"
BLOOD			
Gaffkya spp.			
Sterile rabbit blood susp.	5 yrs.	Frobisher	1947
GENERAL			
Sarcina lutea			
Swabbed in large amounts on tongue, nasal mucous membranes, crypts of tonsils. Impossible to recover in very short time		Bloomfield	1919

TABLE 11 THE SURVIVAL OF THE NEISSERIA SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
N. gonorrheae			
Sterile serum sealed with layer of paraffin	16 mos.	Ungerman	1918
Sterile serum sealed with layer of paraffin	7-8 weeks		
N. meningitidis			
Below 16C., soaked in sterile horse serum	< 24 hrs.	Downie	1940
Nasopharynx, body temp.	Avg. 6 mos. (longest 608 das.; shortest 34 das)	Embleton	1919
N. spp.			
Sterile rabbit blood susp	Neisseria--6 wks-3 mos.	Frobischer	1947
URINE			
N. gonorrheae			
Male with urethritis	----------	Charles	----
20-26C, pH 5-8.5	Two colonies survived 48 hrs.	Carpenter	1933
Sediment 22C., pH 5.0-8.5	8 cols. survived 36 hrs.		
Sediment 4 C., pH 5.0-8.5	13 cols. survived 36 hrs.		
pH increments of from 5.0 to 8.5	Strains isolated--8, 23, 17, 19, 15, 0, 2		
Temperature	----------	Allison	1942
GENERAL			
N. gonorrheae			
Urethral secretion, -5 to 2 C., pH 7.4-7.6, grown on ascitic agar;	1 hr. some reduction	Hamptman	1930
plus 12 C, pH 7.4	8 hrs. some reduction		
plus 22 C, pH 7.4	12 hrs. some reduction		
Urethra, body conditions	< 3 yrs	Keyes	1911
Fresh pus, 22-23 C.	Still viable 24 hrs.	Schofield	1927
Cases successfully treated & operated on.	No survival times	Cohn	1946
N. meningitidis			
Dried human secretions	Several days	Jungleblut	1935

TABLE B12 THE SURVIVAL OF PASTEURELLA SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
P. pestis			
Blood allowed to putrefy in test tube	100 das.	Ostertag	1908
P. of hemorrhagic septicemia			
Physiological serum	5 mos.	Jacotot	1926
FECES			
P. of swine plague			
Swine feces, 8 C.	Recov. 0 in 4-5 das	Gartner	1898
P. spp.			
Sterile feces	Still alive 2 wks-4 mos.	Gladin	1898
SPUTUM			
P. pestis			
Droplets	---------	Teague	1912
URINE			
P. pestis			
Sterile, R.T.	Still alive 3 mos.	Gladin	1898
GENERAL			
P. pestis			
Spleen of infected g.p., -15 C.	Virulent 14 mos., slightly vir. 2 yrs. 7 mos., dead 3 yrs. 5 mos.	Francis	1932
R.H. >37%, temp.>40 F.	Restricted to areas with these factors	Nonr	1951
Corpses of *C. pygmaeus*	Viable 23rd day after death	Novikova	1934
Frozen cadavers in Manchuria	Viable 3 mos. after death	Strong	1942
Cadavers with putrid spleen	4 days	"	"
Cadavers after burial	3-30 das.		
Glycerine in spleen, -15C.	Viable 7 yrs.	Frances	1932
P. tularensis			
23-26 C., internal organs	3 das.	Anon.	1947
Human tissue	Viable M.O. obtained from human tissue 2-3 mos. after pt. recov.	Foshay	1936
Spleens glycerinated, -14C.	10-13 yrs.	Hull	1947
Frozen animal cord	42 mos.		
Frozen brain	36 mos.		
Frozen spleen	18 mos.		
Frozen muscle	12 mos.	"	"
Frozen bone marrow	6 mos.		

TABLE B12 THE SURVIVAL OF RICKETTSIAE IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
R. conorii			
Human blood, ice box	12 d	Blanc	1932
R. rickettsii			
Frozen brain, -70C	95 d	King	1930
R. tsutsugamushi			
Mice blood and tissues	610 d	Fox	1948
FECES			
R. andersoni			
Feces	6 yrs.	Philip	1948
TISSUES, GENERAL			
R. rickettsii			
-70C, frozen brain	321 d	King	1930
R. prowazeki			
Brain, 5C	79 d	Macchiavello	1937
Tunica vaginalis, 5C	92 d	"	"

TABLE B14 THE SURVIVAL OF SALMONELLA SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reverence	
BLOOD			
Sterile rabbit blood susp.	[illegible] yrs.	Frob[illegible]	[illegible]947
FECES			
S. enteriditis			
Fluid stool, R.T., dark	8 d.	Dold	[illegible]
Fluid stool, R.T.	8 d.	"	1943
Fluid Stool, R.T., dark	11 d.	"	19[illegible]
Dried stool, dark, R.T.	53 d.	"	"
S. paratyphi			
Original feces	74 d.	Dold	1947
Dried feces	421 d.	"	"
Fluid stool, dark, R.T.	18 d.	Dold	1944
Stool dried on paper, R.T.	>8 mos.	"	"
Fluid stool, dark, R.T.	20 d.	"	"
Stool dried on paper, R.T.	>5 mos, 16 d.	"	"
S. paratyphi B			
Fluid stool, R.T., dark.	115 d.	Dold,	1944
Fluid stool, R.T.	115 d.	"	1943
S. schottmülleri			
Fluid stool, R.T., dark	18 d.	Dold	1944
Stool dried on paper, R.T.	>8 mos.	"	"
Fluid stool, dark	20 d.	"	"
S. species			
Not found in feces of cockroaches		Macfie	1922
Rat feces, R.T.	148 d.	Welch	1941
S. typhimurium			
Original feces	74 d.	Dold	1947
Dried "	421 d.	"	"
SKIN			
S. enteriditis			
Palmar surf., clean, R.T.	Recov. 0, 10 min.	Arnold	1930
Dirty hands, Body temp.	5% gone, 30 min	"	
Hands, after washing	100% gone, 20 min.	"	"
Palm of hand	Destroyed in 10 min.	Kruege.	1942
Dirty or fatty skin	Several hrs.	Singer	1929
S. Paratyphi			
Dirty or fatty skin	Several hrs.	"	"
S. typhimurium			
Turkey skin, frozen	13 mos!	Browne	1949
TISSUE, GENERAL			
S. typhimurium			
Chicken tissue, 93-96 C.	Inoc. 3.15 X 10^9/gm.	Husseman	1951
after broiling	Recov. .18% in 42 min.		
after roasting	Inoc. 9.36 X 10^9/gm.		
	Recov. 0.1% in 140 min.	"	"

TABLE 8/4 THE SURVIVAL OF SALMONELLA TYPHOSA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
Normal goat serum, dried	Death rate logarithmic in response to conc. of surviving organisms.	Chic[illegible]	1912
Sterile rabbit blood susp.	7 yrs.	Frobi[illegible]r	1947
Sterile " " "	1 str. viable 18 yrs.	"	"
Blood & peritoneal fluid, R.T., air excluded	Virulence preserved >10 yr.	Puntoni	1924
FECES			
Freezing	Several minutes	Beard	1940
Fluid stool, R.T., dark	4 d.	Dold	1944
Fluid Stool, dark	4 d.	"	1943
Stool dried on filter paper, R.T.	> 55 d.	"	1944
Stool, thin, watery, dark, RT.	3 d.	"	"
" " ", dried on filter paper, R.T.	> 137 d.	"	"
Feces in a latrine	30 d.	Galv[illegible]no	1908
Feces in a cask	25 d.	"	
Feces in earth of latrine, buried 10 d.	40 d.	"	
Feces in sand	5-20 d.	"	
Feces in loam	5-15 d.	"	
Feces in gravel	10-20 d.	"	
After being 10 days in latrine the organisms were no longer virulent.		"	
8 C.	Recov. 0 in 5 d.	Gartner	1[illegible]
3 C.	Recov. 0 in 10 d.	"	
Tap water with stool	Inoc. 100,000/cc water Recov. 200/cc water in 2d.	Horrocks	1911
R.T.	52 d.	Jordan	1936
Feces in latrine, winter	5 mos.	Levy	1903
-8 ti -30 F., exposed to open air	40-50 d.	Lu-ti-huan	1[illegible]
Not found in feces of cockroach		Macfie	1[illegible]
12-17 C.	Viable after 4-12 d.	Schiller	1890
Liquid manure	4 d.	"	
Liquid manure, 13-22 C.	9 d.	"	
" " below 12 C.	8 d.	"	
" " above 13 C.	8 d.	"	
Feces & urine, 16-20 C.	Viable 7 d.	"	
8 day cult., below 12C.	Viable 7 D.	"	
10 day cult., below 12 C.	Viable 9 d.	"	
13 day dult., below 12 C.	" 27 d.	"	
15 d. cult., 12-22 C.	Viable 9 d.	"	
5 d. cult., below 12 C.	" 14 d.	"	
" over 18 C.	Viable 8 d.	"	
21 d. cult., below 12 C.	Viable 13 d.	"	
Liquid manure 12-17 C. 6 d. cult.	" 4 d.	"	
Liquid manure, 10 d. cult.	" 4 d.	"	
" " 13 d. cult.	" 7 d.	"	

TABLE 314 THE SURVIVAL OF SALMONELLA TYPHOSA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
FECES, CONT.			
Fresh feces, 17-22 C. weakly acid.	Viable 115 d.	Uffelman	1889
Fresh feces, 17-22 C. neutral	Viable 121 d.	"	
Fresh feces & urine, -22 to 5 C., weakly alkaline	Viable 36 d.	"	
Old feces & urine, 17-22 C. alkaline	Viable 115 d.	"	
Old feces, 10 C. alkaline	Viable 116 d.	"	
Fresh feces, weak acid	" 44 d.	"	
Feces & urine in moist garden soil, 23-0 C.	" 5½ mos.	"	
Fresh feces & urine, neutral, 10 C. or less.	" 66 d.	"	
Fresh feces & urine, weakly alkaline, 10 C. or less	" 21 d.	"	
Human feces on:			
dates	2 d.	Vasquez	1924
vinegar	1 h.	"	
mango	2 d.	"	
banana	2 d.	"	
apple	4 d.	"	
SKIN			
Self sterilizing ability of skin against organism due to drying		Dold	1919
Palm of hand	Entirely destroyed 10 min.	Krueger	1942
Washed hide	Inoc. 550, Recov. 1, 30 minutes	Norton	1932
Dirty or fatty skin	Several hours	Singer	1929
URINE			
Soaked in urine, dark	Inoc. 240,000, Surv. 10 d.	Hewlett	1909
Soil & urine, dry, lab. temp.	Inoc. 12,000/gm soil, Recov. 330/gm. soil, 7 d.	Horrocks	1911
Garden humus with urine, exposed on veranda, no rain, dry.	Inoc. 1,660/gm. soil Recov. 280/gm. soil, 10 d.	"	
Warm temp.	< 20-40 d.	Lu	1933
-8 to -30 F., exposed to open air	40-50 d.	Lu-ti-huan	1930
12-17 C.	Viable after 4-12 d.	Schiller	1890
Urine infected water from well	A few days.	Vacek	1932
7% urine, dil. Ringers with 1% glucose	14 wks.	Zeller	1948
TISSUE, GENERAL			
Skin, clean	Inoc. 4,000, Recov. 1, 10 min.	Arnold	1930
Body temp., dirty fatty skin.	Several hrs.	Arnold	1930
Palmar surf., clean, body t.	Recov. 0,10 min.	"	
Human bile	>160 d.	Beckwith	1921
Beef bile	>141 d.	"	
Oyster juice & stomach, 50-60 F., Ice broth cult.	30 d.	Foote	1895

TABLE B15 THE SURVIVAL OF SHIGELLA SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference
FECES		
S. ambigua		
Desert temp., in open box with flies	297 h.	Stewart 1944
S. dysenteriae		
R.T., 15-18 C.	From 5 to 15 d.	Cruickshank 1942
Fluid stool, R.T., dark	5-14 d.	" 1940
Original feces	31 d.	Dold 1947
Dried feces	113 d.	"
In artificially infected fecal material, the bacilli were detectable 5-4 d. when liquid and 33 d. dried.		" 1943
(Ruhr bacillus), Fluid stool	8.2 d.	" 1944
" " Dried stool	27.2 d.	"
" " Fluid, R.T., dark.	10 d.	"
" " Dried in dark.	1 mo.	"
" " Fluid, dark, R.T.	28 d.	"
Feces, 1.5-15 C. mixed with earth	> 101 d.	Hampil 1932
Stool, cool, dried	1-2 wks.	Joo 1950
Fresh feces	5 d.	Kusama 1925
-8 to -30 F., Exposed to open air.	Up to 55 d.	Lu-ti-huan 1930
Not found in feces of cockroach		Macfie 1922
Desert temp., out of sun.	11 d.	Stewart 1944
Human feces on mango.	1 h.	Vasquez 1924
" " banana	1 h.	"
" " apple	1 h.	"
S. paradysenteriae		
40 C. (flexneri)	96 h.	Barnard 1946
20 C. "	48 h.	"
30 C. "	24 h.	"
R.T. "	Dried out quickly in fecal specimens	Cruickshank 1940
Dried feces "	32 d.	Dold 1947
Original feces (Paradys.)	97 d.	"
Dried feces "	270 d.	"
Original feces (Hiss Y)	3 d.	"
Dried feces "	12 d.	"
Original feces (flexneri)	31 d.	"
Dried feces "	113 d.	"
Desert temp., out of sun	273 d.	Stewart 1944
Direct sun, all day.	1 hr. 20 min.	"
Human feces on mango	5 hrs.	Vasquez 1924
" " banana	2 h.	"
" " apple	4 d.	"
S. sonnei		
20 C.	72 h.	Barnard 1946
30 C.	24 h.	"
37 C.	6 h.	"
R.T.	6-11 d.	Cruickshank 1940
Feces	1-14 d.	Lowbury 1943

TABLE B15 THE SURVIVAL OF SHIGELLA SPECIES IN THE BODY. (AND BODY MATERIALS)

Factor(s)	Survival	Reference
URINE		
S. dysenteriae		
Urine, warm, indoor,	40-50 d.	Lu 1933
-8 to -30 F., Exposed to open air.	55 d.	Lu-ti-huan 1930
TISSUES, GENERAL		
S. dysenteriae		
Filtered human gastric juice, pH 4.5	Germicidal for Sonne-Duval strain of S. dysenteriae	Felsen 1939

TABLE B/b THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference
BLOOD		
S. fecalis		
Sterile rabbit blood susp.	7-19 yrs.	Frobisher 1947
S. hemolyticus		
R.T., liquid paraffin, arachis oil	8 wks. 4 wks.	Coulthard 1951
Refrig., liquid paraffin, arachis oil	4 wks. > 37 wks.	"
Saliva, R.H., 40-55%	Mortality rates smaller than pneumococcus.	Dunklin 1948
Sterile rabbit blood susp.	Alive 18 yrs. (Beta)	Frobisher 1947
" " "	" 9 yrs. (Alpha)	"
S. liquefaciens		
Sterile rabbit blood susp.	7-19 yrs.	"
S. spp.		
Horse serum, 55 C.	--	Belin 1933
37 C. for 3 hrs., defibrinated. Sprayed from chamber.	Increased from 600 org. per unit to 50,000/unit in 1-7 days.	Buchbinder 1941
SKIN		
S. pyogenes		
Fingers, exposed 2 min.	Inoc. 1270, wash off 329	Burtenshaw 1938
" " 54 min.	" 1228, " 190	"
" " 118 "	" 339, " 3.1	"
Palm, exposed 2 min.	" 1270, " 50.6	"
" " 54 min.	" 1228, " .32	"
" " 118 min.	" 339, " 96	"
Forearm " 2 min.	" 1971, " 157	"
" " 64 "	" 1228, " 78	"
" " 120 "	" 339 " 78	"
Dead skin, " 3 min.	" 1971 " 88	"
" " 65 min.	" 1228 " 232	"
" " 120 "	" 339 " 14	"
Left palm, exposed 4 min.	" 48 " .22	"
Right palm, " 4 min.	" 48 " 0	"
Exposed to long chain fatty acids.	Lethal	Burtenshaw 1945
S. hemolyticus		
Normal skin of hand, R.T. From broth culture.	Recov. 30 million, 3 min.	Colebrook 1930
	" 1.7 " 1 h.	"
	" 7,000 2 h.	"
Hands of normal person	Group A isolated from hands of 7 out of 181. Non-hemolytic on nearly all of hands.	"
Skin of hands.	6% viable, 1 h.	Krueger 1942
Washed hide	Inoc. 1400, Recov. 400 30 min.	Norton 1932
Surface, washed hide	Inoc. 1,000, Recov. 75, 30 min.	"
Wounds	Alpha strep. found in 3 of 82 wounds.	

TABLE B16 (CONT.) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
SKIN (CONT.)			
S. pneumoniae			
Exposed to long chain fatty acids	Lethal	Burtenshaw	1945
S. viridans			
Exposed to long chain fatty acids.	Lethal	"	
SPUTUM			
S. hemolyticus (Beta)			
Dried, 37 C.	Viable at 150 d.	Germano	1897
Saliva	In 20% no strep. demonstrable. 80% same strep. as in throat culture.	Hamburger	1944
TISSUE, GENERAL			
S. hemolyticus (Beta)			
Dried membrane, 37 C.	Viable after 3 mos.	Germano	1897
Nasal secretion	Recoverable after last normal hand washing.	Hamburger	1946
Nose & throat, sulfadiazine 1 gm/day.	More marked sensitivity in nose than throat.	"	
Survived longer on skin than on filter paper.		Hellat	1948
Throat swabs, ice box, dried.	½ yr.	Jettman	1927
S. spp.			
Animal excreta, 61 F.	Inoc. 1-3, Recov. .03 in 7 d.	Savage	1917

TABLE B17 THE SURVIVAL OF VIBRIO SPECIES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
V. comma			
R.T., dry, glass smear, fowl.	8 d.	Skidmore	1932
Turkey blood, 5 C., dried on glass	47 h.	"	
Turkey blood, 37.5 C., dried on glass	47 h.	"	
Beef bouillon, 37.5 C. in test tubes	Viable 5 wks.	"	
FECES			
V. comma			
Flies in contact with mat'l. rich in organisms.	Found in feces	Alessandri	-
Abs. humidity, 10-11 mg/cu. meter	Long enough for infection	Bey	1948
30 C.	Recov. 0 in 10 d.	Gartner	1898
8 C.	" " 5 d.	"	
Rice water stools, dark cool weather	7-8 d.	Greig	1913
Rice water stools, dark warm weather.	1-2 d.	"	
-8 to -30 F., Exposed to open air.	6-30 d.	Lu-ti-huan	1930
Feces	14 d.	Schiller	1890
Liquid manure	13 d.	"	
Fresh feces & urine, 17-22 C., weak acid	Viable 24 h.	Uffelman	1889
9 C., weak acid	Viable 24 h.	"	
Old feces, thin with water. 17-22 C., weak alk.	Viable 96 h.	"	
9 C., weak alkaline	Viable 24 h.	"	
Fresh feces & urine, 17-22 C.	Viable 72 h.	"	
9 C. or less	Viable 24 h.		
Diarrheic feces & urine, 17-22 C.	Viable 48 h.	"	
9 C. or less	Viable 48 h.	"	
Human feces on chico, cucumbers, papaya, lettuce	Overnight	Vasquez	1924
Human feces on cut cucumb.	> 20 hrs.	"	
" " " " papaya	< 44 hrs.	"	
" " " shrimp	22 hrs.	"	
" " " oysters	46 h.	"	
" " " inside open clam.	4 d.	"	
" " " dates	2 hrs.	"	
" " " vinegar	1 h.	"	
" " " mango	2 d.	"	
" " " banana	2 d.	"	
URINE			
V. comma			
Urine, warm, indoor.	< 20-40 d.	Lu	1933
-80 to -30 F., open air	6-30 d.	Lu-ti-huan	1930
Urine	14 d.	Schiller	1890

TABLE B18

THE SURVIVAL OF VIRUSES
IN THE BODY
(AND BODY MATERIALS)

Factor(s)	Survival	Reference	
BLOOD			
Hoof & Mouth virus			
-20C., thawed at R.T., 24 hrs. previous to test.	6-7 weeks	Henderson	1948
-10 to-20 C., thawed when tested	5 3/4 mos.		
G.p. lymph, pH 7.5, in phosphate buffer	2 yrs and 20 das.	Sichert-Modrow	1930
Dried lymph 70 C., dried in P_2O_5 in vacuo	2 1/2 hrs.		
Dried lymph 122 C., dried with P_2O_5 in vacuo	3 min.	"	"
Dried lymph of g.p., 52 C in P_2O_5	Still infectious 14 hr.		
Dried lymph of g.p., R.T.	Still infectious 10 das	"	"
Dried serum, R.T.	Still infectious 5 das.		
Dried plasma, R.T.	Still infectious 7 das.		
Dried preserved serum, R.T	Still infectious 48 das	"	"
Fresh g.p. lymph, 2-7 C., stored in cold room	Retained virulence 190 das.	Stockman	1926
Herpes			
U.V. radiation, fresh normal rabbit serum	10 min.	Gunderson	1932
Normal rabbit serum	40 min.	McKinley	1926
Mexican typhus			
Blood and tissue, 5 C.	79 das.	Macchiavello	1937
Yellow Fever virus			
Blood dried in vacuum while frozen	154 das.	Sawyer	1929
Monkey blood with liver, -10 C., in sealed sterile test tube	2 wks.	Sellards	1928
Rift Valley Fever			
Blood, refrigerator	62 days	Smithburn	1949
Blood, refrigerator(stored, fluid)	2 yrs.		
Serum, refrigerator	1048 das.	"	"
FECES			
Hoof & Mouth virus			
Inoc. g.p. tissue & stored -20C.	2-3 mos.	Andrews	1931
Moist, cool, 3.5-5.5 C., for 105 das., dried rapidly in vacuum, R.T.	283-345 Days	Hull	1947
Infective Jaundice			
Dust borne, dried	31 das.	Anderson	1947
Newcastle virus			
Dried chicken feces, pH 6.3 and 6.8		Olesiuk	1951
Psittacosis			
Exposed to HCOH, 0.2%, R.T.	Infective up to 10 das	Hull	1947

TABLE B/8 (CONT'D) THE SURVIVAL OF VIRUSES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
FECES (CONT'D)			
Polio virus			
3-4 C.	>6 mos.	Kramer	1940
Stools	7-8 wks.	Horstmann	1944
Feces of child	Recov. 7 das, after on-set of illness	Kramer	1939
Stools, virus found in stools, inactivated by in-activated sludge and chlorination		Krumbiegel	1944
Stools of convalescents	25 and 123 das. after mild abortive polio	Lepine	1939
Feces of polio victims & carriers	Possibly a matter of hrs	Maxcy	1943
Stool	<6% viable	Paul	1941
Stool in transatlantic mail	16 das.	Paul	1939
Aqueous stool suspn., ice box.	2 1/2 mos.	Paul	1940
Refrigerated	10 wks.	Trask	1938
Stools of convalescents	25-123 das. after ab-ortive cases		
Refrigerated	75 days	"	"
SKIN			
Influenza virus			
Human skin, inoc. 0.2cc virus suspn.	50% recov. in 10 min.	Krueger	1942
Suspended in chick allan-toic fluid, skin of hand	45-50 min.	Parker	1944
Vaccinia virus			
Light reduced 1/2	Pustule up to 8 hr.	Herzberg	1933
SPUTUM			
Virus spp.			
R.T.	Recovery positive, 92das	Arloing	1927
GENERAL			
Hoof & Mouth virus			
Inoc. g.p., 2 C.	2-3 mos.	Andrews	1931
Beef, -20 C, buffered sol.	4 mos.	Henderson	1948
Tissues, liver, kidney, rumen, 4 C.	24 hrs.		
Liver, rumen, lymph node, -10to -20 C., thawed when tested	5 3/4 mos.	"	"
4 C. pH 5.6	<3 das.	"	"
-20 C., pH 6.8, thawed in buffered sol'n.	11 das		
120 C., ph 6.6, thawed in buffered sol'n.	4 mos.	"	"
Muscles, near 0	1 wk	Rubino	1929
Bone	At least 40 das		
Carcass, -20C., pH 6.8 thawed at R.T.	4 mos.	Henderson	1948
Rinderpest virus			
Live rabbits & storage	7 das.	Haddow	1947

TABLE B/ (CONT'D) THE SURVIVAL OF VIRUSES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
GENERAL (CONT'D)			
<u>Polio virus</u>			
Brain tissue, 37 C., in ascitic fluid kidney	20 but not 30 das.	Flexner	1915
Polio stored in animal tissue over long period of time does not retain viability.		Flexner	1917
Nasal washings of child	Recov. 5 das. after onset of illness	Kramer	1939
Nasopharyngeal washing	Recov. 9 das. after onset of illness		
Pharynx	Recov. 10% viable	Paul	1941
Fresh prep. in amoeba proteus	<3 das.	Toomey	1948
<u>Rabies</u>			
Rabbit brain, 5 C.	>68 das.	Remlinger	1934
Brain in glycerin , in disintegrator	47 das	Barrat	1904
Brain susp'n in liquid air, dil. 1:10	24 hrs.		
pH 2,	1 hr.	Dresel	1934
Acids & alkalis harmful in proportion to conc.			
<u>Herpes virus</u>			
20% susp'n of rabbit brain in buffered physiological saline, 37 C.	100 hrs.	Book	1940
Brain emulsion	40 min	McKinley	1926
U. V. radiation, cornea	<15 min.	Gunderson	1932
<u>Yellow Fever virus</u>			
Liver, -12 C.	>1 mo.	Sawyer	1929
Mouse brain, 8 C.	Non-virulent, 160 das.	Theiler	1930
Mouse brain plus 50% glycerin, stored at 2-4C.	Infective after 58 das. but not often 100 das.		
Mouse brain in whole monkey serum, -78 C.	6 mos.	Turner	1938
<u>Influenza virus</u>			
Palmar skin	Recov. 0 in 10 min.	Anon.	1943
Mouse brain susp'n in N rabbit serum, -20to -30C.	<6 mos.	Olitsky	1949
Mouse lung susp'n in 10% plain broth, -78C	6 mos.	Turner	1938
Frozen rabbit testes, -78 C.	3 yrs.	Turner	1939
<u>Newcastle Disease virus</u>			
Skin, eviscerated carcass, 34 F., exp. infected	96 das	Asplin	1949
Bone marrow	134 das		
Unplucked carcasses, skin;	160 das		
bone marrow	196 das	"	"
<u>Fowlpox virus</u>			
Dried material from lesions	2 yrs.	Loewenthal	1906

TABLE B/[illegible] (CONT'D) THE SURVIVAL OF VIRUSES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
GENERAL (CONT'D)			
Polio virus			
Brain tissue, 37 C., in ascitic fluid kidney	20 but not 30 das.	Flexner	1915
Polio stored in animal tissue over long period of time does not retain viability.		Flexner	1917
Nasal washings of child	Recov. 5 das. after onset of illness	Kramer	1939
Nasopharyngeal washing	Recov. 9 das. after onset of illness		
Pharynx	Recov. 10% viable	Paul	1941
Fresh prep. in amoeba proteus	< 3 das.	Toomey	1948
Rabies			
Rabbit brain, 5 C.	> 68 das.	Remlinger	1934
Brain in glycerin, in disintegrator	47 das	Barrat	1904
Brain susp'n in liquid air, dil. 1:10	24 hrs.		
pH 2,	1 hr.	Dresel	1934
Acids & alkalis harmful in proportion to conc.			
Herpes virus			
20% susp'n of rabbit brain in buffered physiological saline, 37 C.	100 hrs.	Book	1940
Brain emulsion	40 min	McKinley	1926
U. V. radiation, cornea	< 15 min.	Gunderson	1932
Yellow Fever virus			
Liver, -12 C.	> 1 mo.	Sawyer	1929
Mouse brain, 8 C.	Non-virulent, 160 das.	Theiler	1930
Mouse brain plus 50% glycerin, stored at 2-4C.	Infective after 58 das. but not often 100 das.		
Mouse brain in whole monkey serum, -78 C.	6 mos.	Turner	1938
Influenza virus			
Palmar skin	Recov. 20 in 10 min.	Anon.	1943
Mouse brain susp'n in N rabbit serum, -20to -30C.	< 6 mos.	Olitsky	1949
Mouse lung susp'n in 10% plain broth, -78C	6 mos.	Turner	1938
Frozen rabbit testes, -78 C.	3 yrs.	Turner	1939
Newcastle Disease virus			
Skin, eviscerated carcass, 34 F., exp. infected	96 das	Asplin	1949
Bone marrow	134 das		
Unplucked carcasses, skin;	160 das		
bone marrow	196 das	"	"
Fowlpox virus			
Dried material from lesions	2 yrs.	Loewenthal	1906

TABLE B18 (CONT'D) THE SURVIVAL OF VIRUSES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
GENERAL(CONT'D)			
Vaccinia virus			
Mouse brain, 4 C., Dried over CaCl2 in sealed glass vessels	Still virulent to mice in 71 hrs.	Haagen	1939
Mouse brain tissue, 20% glycerin in water, strain II Neurolapine R.G.A.	Recov. after 28th passage-10 mos.	"	"
Mouse, brain, temp. of freezing-drying apparatue, strain II Neurolapin R.G.A.	Recov. after 1 yr 9 mos	"	"
Mouse brain tissue, 4 C., strain II L 3 b.	Recov. after 2 yrs.	"	"
Mouse brain tissue plus glycerin, refrigerated, Strain II L 3 b.	Not virulent after 1 yr.		
Mouse brain, temp. of freezing-drying apparatus, Strain II L 3 b	Still showed skin reaction after 1 yr.	"	"
Mouse brain plus glycerin Strain II L 3 b	Still showed skin reaction after 6 mos.	"	"
Chorion plus calf lymph, temp. of refrigerator, Strain III Breslan	Still showed skin reaction after 2 yrs.		
Chorion plus calf lymph, temp. of refrigerator, Strain IV Dresden	Still virulent after 2 yrs.	"	"
Chorion, 4 C. Strain V Hanover	Not given	"	"
Neurotropic viruses			
-20 to -30 C.	9 mos.	Olitsky	1949
Encephalitides			
Brain tissue, 50% glycerin	1 yr.	Hull	1947
Dried	Lose virulence		
Frozen	>3 mos.		
pH below 5.5	Lose viability		
pH 9.2	Viability returns	"	"
Mouse brain susp'n in N rabbit serum -20to -30C (Jap.B encephalitis)	<6 mos	Olitsky	1949
Mouse brain emulsion in plain broth, -78C.	6 mos.	Turner	1938
Meningo-meningitis			
Frozen rabbit testes,-78C	3 yrs.	Turner	1939
Lympho-granuloma inguinale			
Frozen rabbit testes,-78C.	10 mos.		
Smallpox virus(Variola)			
Dry crusts, R.T., daylight and dark	Long periods >1 yr.	Downie	1947

TABLE B18 (CONT'D) THE SURVIVAL OF VIRUSES IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	Reference	
GENERAL(CONT'D)			
Pneumoenteritis virus			
Calf lung, 60, filtered thru Berk. or Seitz filter	Recov.0 in 10 min.	Gallo	1948
55 C., filtered, dried	Still active in 10 min.		
Dried lung in refrigerator	No activity, 20 das.		
Frozen dried lung	No activity, 6 das.	"	"
Virus spp.			
Some viruses retain their activity in vitro for several yrs. Some bacteriophage endure for a long time in bacteria free filtrate		Boycott	1928
Leukocytes and spleen tissue, 4 C., dried by ppt. by cold acetone	>2 mos.	Das	1949
4 C. dried over calcium chloride in vacuum	>4 mos.		
37 C.	15 das.		

TABLE B19 THE SURVIVAL OF GENERAL BACTERIA IN THE BODY (AND BODY MATERIALS)

Factor(s)	Survival	REFERENCE
Gastric juice	Organisms recovered 5½ hrs. after feeding dogs 500 cc. alk. milk with organisms.	Arnold 1926
Sweat. Freshly secreted. May have mild antiseptic value due to acid pH imparted by lactic acid.		Bergeim 1943
Tissue surfaces in contact with environment rich in bacteria as respiratory and digestive tract have strong inhibitory effect on bacteria which is lacking on tissue surfaces of the body cavities such as pleura, pericardium, peritoneum. Saliva plays important role since it contains inhibitors sensitive to cold, soluble in water and precipitated by alcohol, chloroform, and acetone.		Dold 1947
4 days since bath. Skin scrapings.	Deltoid area: aerobic 70 organisms. Anaerobic 37 "	
7 days since bath. Skin scrapings.	Scapular area: aerobic, 47 organisms. anaerobic, 10 "	Evans 1950
Saliva sprayed in air	36 hrs.	Lukriech 1947
Hands & arms.	Inoc. 4,580,000, Recov. 1,000,000 after scrubbing 14 min.	Price 1938
Sores on man & beast, 110-120 F. Sun on sores.	Organisms destroyed.	Sternberg 1894

References (Body)

1. Abe, T. 1949 Ueber die Lebensdauer der Tuberkelbazillen in Exkreten. I. Einflub der Temperatur. Tohoku J. Exper. Med., 50, 329-336.
2. Abel, R. 1897 Zur Kenntnis des Pestbacillus. Centr. Bakt., 21, 497-517.
3. Albini, A. 1940 Action of sunlight and of other meteorologic factors on tubercle bacilli. Rassegna internaz. di Clin. E Terap., 21, 828-833.
4. Alessandrini, G., and Sampietro, G. The vitality of cholera vibriones in milk and on the fly. Ann. Igiene Sper., 22, 623-650.
5. Allison, S.D., Charles, R., and Carpenter, C.M. 1942 Survival time of gonococcus in urine from male patients with urethritis. Venereal Disease Inform., 23, 283-286.
6. Amoss, H.L., and Poston, M.A. 1929 Undulant (Malta) fever: isolation of the brucella organism from the stools. J. Am. Med. Assoc., 93, 170-171.
7. Anderson, I.S. 1947 Infective jaundice in Iceland. Lancet, 252, 778-781.
8. Andrews, W.H., Dobson, N., Bannatyne, T., Davies, G.O., Simmins, G.B., Watkins, C.V., and Evans, J.T. 1931 Foot and Mouth Disease Commission, London.
9. Anonymous 1923 Official history of the War Medical Services. Pathology, London, 142.
10. Anonymous 1933 Rep. N.Y. St. Vet. Coll. 1931-1932.
11. Anonymous 1943 The inactivation by human skin of influenza virus in the presence of saliva. U.S. Naval Med. Bull., 41, 692-697.
12. Anonymous 1947 Regional types of tularemia nidi of the central zone of the RSFSR. Zoologicheskiy Zhurnal, 26.
13. Arkharow, J. 1892 Recherches sur la guerison de l'infection pneumonique chez les lapins au moyen du serum des lapins vaccines. Arch. d. med. exper. et d'anat. path., 4, 498.
14. Arkwright, J.A., and Balot, A.W. 1923 Investigation of the etiology of typhus fever, especially undertaken for the Egyptian government in the Public Health Laboratories, Cairo. Brit. J. Exp. Path., 4, 70.
15. Arloing, F., and Dufourt, A. 1927 Temps de conservation du virus filtrant tuberculeaux dans les produits pathologiques. Compt. rend. soc. biol., 96, 453-455.
16. Arms, B.L., and Wade, E.M. 1912 Variations in the longevity of tubercle bacilli from different individuals. Trans. Nat. Assoc. Prev. Tuberc., 493-497.
17. Armuzzi, G., and Strempel, R. 1926 On the behaviour of Spirochaeta pallida in dead tissue. Arch. F. Dermat. u. Syph., 150, 295.
18. Arnold, L., and Bart, A. 1934 The self-disinfecting power of the skin. Am. J. Hyg., 19, 217-228.
19. Arnold, L., and Brody, L. 1926 The gastro-duodenal bactericidal mechanism. Am. J. Hyg., 6, 672.
20. Arnold, L., Gustafson, C.J., Hull, T.G., Montgomery, B.E., and Singer, C. 1930 The self-disinfecting power of the skin as a defense against microbic invasion. Am. J. Hyg., 11, 345.
21. Asplin, F.D. 1949 Observations on the viability of Newcastle disease virus. Vet. Rec., 61, 159-160.

22. Atkinson, N. 1934 The occurrence of Aerobacter aerogenes in sewage and feces. Australian J. Exp. Biol. Med. Sci., 12, 141-149.
23. Bang, B. 1897 Die Aetiologie des seuchenhaften Verwerfens. Z. F. Thier., 1, 241-278.
24. Barnard, H.F. 1946 Effect of temperature on survival of Shigella sonnei and Shigella flexneri in feces. Month. Bull. Min. Health and Emerg. Pub. Health Lab. Serv., 5, 261-264.
25. Beard, P.J. 1940 Longevity of Eberthella typhosus in various soils. Am. J. Pub. Health, 30, 1077.
26. Beaver, P.C., and Deschamps, G. 1949 The viability of E. histolytica cysts in soil. Am. J. Trop. Med., 29, 189-191.
27. Beckwith, Lyon, 1921 Viability and growth of B. typhosus in bile. J. Infectious Diseases, 28, 62.
28. Bergeim, O., and Cornbleet, T. 1943 Antibacterial action of lactic acid and volatile fatty acids of sweat. Am. J. Med. Sci., 205, 785-792.
29. Blanc, G., and Baltazard, M. 1937 Long period of conservation, in dried excrement of infected fleas, of typhus virus. Compt. rend. Acad. d. Sc., 204, 1046-1048.
30. Blanc, G., and Caminopetros, J. 1932 Etudes epidemiologiques et experimentales sur la fievre boutonneuse faites a L'institut Pastuer d'Athenes. Arch. Inst. Pasteur, Tunis, 20, 343-349.
31. Bloomfield, A.L. 1919 Fate of bacteria introduced into upper air passages. Bull. Johns Hopkins Hosp., 30, 317.
32. Boak, R.A., Carpenter, C.M., and Warren, S.L. 1932 Thermal death time of Treponema pallidum in vitro, with special reference to fever temperatures. J. Exp. Med., 56, 741-750.
33. Boch, O. 1941 Loss of virulence of Treponema pallidum in citrated blood. Bull. Johns Hopkins Hosp., 68, 412.
34. Bordoni-Uffreduzzi, G. 1891 Sulla Resistenzo Del Virus Pneumonico Nezli Sputi. Arch. Sci. Med., 15, 341-348.
35. Bormann, F. von 1940 Beitrag über die Haltbarkeit der Staphylococcen im Eiter. Zentr. Bakt., 146, 68-69.
36. Boycott, A.E. 1905 Ankylostomiasis. Trans. Epidemiological Soc., London, 24, 113-142.
37. Boycott, A.E. 1928 Transition from live to dead; nature of filterable viruses. Proc. Royal Soc. Med., 22, 1-15.
38. Braun, W., Gorelick, A.N., Kraft, M., Mead, D. 1951 Studies on the in vivo fate of brucella variants with different virulence. J. Infectious Diseases, 89, 286-295.
40. Brown, H.W. 1927 Studies on the rate of development and viability of the eggs of Ascaris lumbricoides and Trichuris trichura under field conditions. J. Parasitol., 14, 1-15.
41. Browne, A.S. 1949 The public health significance of salmonella on poultry and poultry products. Ph.D. Thesis, U. Calif.
42. Brumpt, E. 1932 Longevite du virus de la fievre boutonneuse chez la tique, Rhipicephalus sanguinens. Compt. rend. soc. biol., 110, 1199-1202.
43. Bryan, C.S., and Mallman, W.L. 1933 Some factors responsible for the so-called self-disinfecting power of the skin. J. Lab. Clin. Med., 18, 1249-1255.
44. Buchanan, G. 1927 Spec. Rep. Ser. Med. Res. Coun., London, #113.
45. Buchbinder, L., Solotorovsky, M., Solowey, M., and Ruhlkoupal, J. 1941 Studies on microorganisms in simulated room environments. V. The effect of survival on the pathogenic properties of streptococci: properties other than mouse virulence. J. Bact., 42, 631-634.

46. Burke, G.S. 1919 Occurrence of B. botulinus in nature. J. Bact., 4, 541.
47. Burns, N.B. 1917 Some experiments with tuberculous sputum twenty-two years old. Am. Rev. Tuberc., 1, 484-488.
48. Burtenshaw, J.M.L. 1938 Mortality of Streptococcus hemolyticus on skin and other surfaces. J. Hyg., 38, 575-586.
49. Burtenshaw, J.M. 1945 Self-disinfection of the skin: a short review and some original observations. Brit. Med. Bull., 3, 161-164.
50. Cadeac, N.I., and Malet, N.I. 1888 Research experiments on the virulence of purulent matter, dried, putrified or frozen. Congres pour l'etude de la tuberculose, 310.
51. Caldwell, M.E. 1925 Viability of Mycobacterium tuberculosis in semi-arid environments. J. Infectious Diseases, 37, 465-472.
52. Caldwell, F.C., and Caldwell, E.L. 1928 Preliminary report on observations on the development of ova of pig and human Ascaris under natural conditions, and studies of factors influencing development. J. Parasitol., 14, 254.
53. Calmette, N.I. 1920 L'infection bacillaire et la tuberculose.
54. Cameron, H.S. 1933 Rep. N.Y. St. Vet. Coll., 1931-1932.
55. Canfora, M. 1907 Ueber die Latenz der Tetanussporen im tierischen Organismus. Centr. Bakt., Abt. I., Orig., 45, 495-501.
56. Cedar, E., Dyer, R., Rumreich, A., and Badger, L. 1931 Typhus fever: typhus virus in feces of infected fleas (Xenopsylla cheopis) and duration of infectivity of fleas. Pub. Health Rep., 46, 3103-3106.
57. Chausse, P. 1912 Compt. rend. acad. sci., 155, 486.
58. Chief, Military, Sanitary Admin. of the Red Army. 1944 Manuel of Infectious Diseases, Medgiz, Moscow, 201.
59. Cohn, A., Grunstein, L., and Heaton, C.E. 1946 Persistence of gonococcus in female adnexa. Am. J. Obstet. and Gynecol., 52, 83-88.
60. Cohn, E.G. 1950 Koliforme bakterier i kogødning og ra maelk. Nordisk Veterinaermed, 2, 209-236.
61. Colebrook, L. 1930 Min. Hlth. Inter. Rep. Dep. Comm. Matern. Mortal. Morb., Appendix D.
62. Colebrook, L., Maxted, W.R., and Johns, A.M. 1935 Presence of hemolytic and other streptococci on human skin. J. Path. Bact., 41, 521-527.
63. Cornbleet, T. 1932 Self-sterilizing powers of the skin. II. Arch. Dermatol. and Sypholol., 25, 1058-1059.
64. Cornbleet, T. 1934 Self-sterilizing powers of the skin. V. Arch. Dermatol. and Sypholol., 28, 526-531.
65. Cornbleet, T., Montgomery, B.E. 1931 Self-sterilizing powers of the skin. I. Arch. Dermatol. and Sypholol., 23, 908-919.
66. Cornet, G. Tuberculosis and acute generalized tuberculosis. American edition by James, W.B., and Stengel, A.
67. Cornet, G. 1904 Tuberculosis, 83.
68. Cort, W.W. 1925 Investigations on the control of hookworm disease. XXXIV. Am. J. Hyg., 5, 49.
69. Cort, W.W., Grant, J.B., Stoll, N.R., Et Al. 1926 An epidemiologic study of hookworm disease in the mulberry districts of the Yangtze delta. Am. J. Hyg., Monog. # 7.

70. Coulthard, C.E., Chantrell, B.H., Croshaw, B. 1951 The survival of streptococci and tubercle bacilli in oils; with special reference to those of pharmaceutical interest. J. Pharmacol., London, 3:4, 215-226.
71. Cruickshank, R., and Gillespie, M. 1942 Diagnosis of intestinal infections. Lancet, 2, 322.
72. Cruickshank, R., and Swyer, R. 1940 Outbreak of Sonne dysentery. Lancet, 803.
73. Da Rocha-Lima, H. 1916 Zur Aetiologie des Fleckfiebers. Berliner Klin. Wochenschrift, 53, 567-569.
74. Davies, R. 1939 Influence of normal blood and certain of its constituents on growth and viability of the tubercle bacillus. Tubercle, 20, 5-49.
75. Davis, G.E. 1943 Further attempts to transmit Pasteurella tularensis by the bedbug. J. Parasitol., 29, 395-396.
76. De Thoma, N.I. 1886 Sulla Virulenza Dello Sputo Tuberculare. Annali Univers. Di Medic. Juillet.
77. D'Herelle, F., Malone, R.H., and Lahiri, M.N. 1930 Studies on Asiatic cholera. Indian Med. Res. Mem., No. 14.
78. Dobell, C.E. 1936 Researches on the intestinal protozoa of monkey and man. VIII. An experimental study of some Simian strains of "Entamoeba coli". J. Parasitol., 28, 541-593.
79. Dold, H. 1943 Ueber die Infektionsgefahr durch Wäsche, die mit Krankheitskeimen (Typhus, Paratyphus, Enteritis und Ruhrbazillen) verunreinigt ist. Arch. Hyg. u. Bakt., 131, 134-149.
80. Dold, H. 1944 Danger of infection from "washing" soiled with organisms of typhoid-paratyphoid-dysentery group. Bull. War Med., 5, 132.
81. Dold, H., Chen Wu Hsiang 1919 Uber das Verhältnis der Tatsächlichen zur theoretisch Möglichen gefahr der Keimübertragung durch Fingerberühnungen. Z. Hyg. Infektionskrankh., 89, 266-284.
82. Dold, H., and Ketterer, M. 1943 Vergleichende Untersuchungen über die Wachweisbarkeit von Ruhrbazillen in flüssigem und getrocknetem Stuhlmaterial. Z. Hyg. u. Infektionskrankh., 125, 215-225.
83. Dold, H., and Ketterer, M. 1944 Comparative studies on survival time of bacteria of typhoid-paratyphoid-enteritis group and dysentery group in liquid fecal matter and in feces dried on filter paper. Z. Hyg. u. Infektionskrankh., 125, 444-456.
84. Dold, H., and Ketterer, M. 1947 Weitere vergleichende Untersuchungen über die Nach weisbarkeit von Bakterien der Ruhrgruppe und der T.P.E. gruppe in flüssigem oder an filtrier Papier angtrocknetem Stuhlmaterial. Z. Hyg. Infektionskrankh., 127, 326-333.
85. Downie, A.W. 1940 Survival of meningococci on swabs and blood. Lancet, 2, 36-37.
86. Downie, A.W., and Dumbell, K.R. 1947 Survival of Variola virus in dried exudate and crusts from smallpox patients. Lancet, 1, 550-553.
87. Dresel, E.G., and Sander, F. 1934 Distribution of rabies virus in the organs of rabbits and the influence of acids and alkalis on the virus. Z. Immunitätsforsch., 81, 457.

88. Du Buy, H., Arnold, F.A., and Olson, B.J. 1947 Air transmission of microorganisms derived from the respiratory tract. I. Lactobacillus acidophilus as a test organism. U.S. Pub. Health Repts., 62, 1391-1413.
89. Duguid, J.P. 1946 Expulsion of pathogenic organisms from the respiratory tract. Brit. Med. J., 1, 265.
90. Dunklin, E.W., and Puck, T.T. 1948 The lethal effect of relative humidity on air-borne bacteria. J. Exptl. Med., 87, 87-100.
91. Dykstra, R., Roderick, L., Farley, H., McMahan, V., and Splitter, E. Tech. Bull. Kansas Agric. Exptl. Sta., 66, 1-24.
92. Easton, E.J., and Meyer, K.F. 1924 Occurrence of Bacillus botulinus in human and animal excreta. J. Infectious Diseases, 35, 207-212.
93. Embleton, D., and Steven, G.H. 1919 The persistence of cerebro-spinal fever cases as carriers. Lancet, 1, 788-790.
94. Emmerich, R. 1894 Ueber die Infection, Immunisirung, und Heilung bei croupöser Pneumonie. Z. Hyg. u. Infektionskrankh., 17, 167-184.
95. Emmerson, H. 1933 Sunlight and health. Am. J. Pub. Health, 23, 437-440.
96. Enders, J.F., and Pearson, H.E. 1941 Resistance of chicks to infection with influenza A virus. Proc. Soc. Exptl. Biol. and Med., 48, 143.
97. Eskey, C.R. 1938 Fleas as vectors of plague. Am. J. Pub. Health, 28, 1305-1310.
98. Eskey, C.R., and Haas, V.H. 1939 Infection in rodents, experimental transmission by fleas, and inoculation tests for infection. Pub. Health Bull., Wash., No. 32, 1467.
99. Evans, C.A., Smith, W.M., Johnston, E.A., and Giblett, E.R. 1950 Bacterial flora of the normal human skin. J. Investigative Dermatol., 15, 305-324.
100. Eyre, J.W.H. 1908 The Milroy lectures on Melitensis septicemia. Lancet, 1, 1677-1682, 1747-1752.
101. Falk, A. 1947 Water-borne tularemia (incurred during handling of fish). Minnesota Med., 30, 849-850.
102. Falk, L.L. 1949 Bacterial contamination of tomatoes grown in polluted soil. Am. J. Pub. Health, 39, 1338-1342.
103. Faust, E.C. 1924 Some facts regarding the relation between nightsoil disposal in China and the propagation of helminthic diseases. Am. J. Trop. Med., 4, 487-503.
104. Felsen, J., and Osofsky, A.G. 1939 Gastric barrier in bacillary dysentery. Arch. Int. Med., 63, 64.
105. Felsenfeld, O., Young, V.M., and Conner, P. 1947 Progress in the knowledge of gram negative enteric pathogenic organisms during the year from 1938-1945. Pontifica Academia Scientiarum, 16, 1-75.
106. Flexner, S., and Amoss, H.L. 1915 Diffusion and survival of the poliomyelitis virus. J. Exp. Med., 21, 509-514.
107. Flexner, S., and Amoss, H.L. 1917 Survival of the poliomyelitis virus for six years in glycerol. J. Exp. Med., 25, 539-544.
108. Flügge, C. 1921 Die Bedeutung der Verstreuung von Hustentröpfchen für die Verbreitung der Phthise. Z. F. Tuberk., 34, 212-228.

109. Foa, P., and Bordoni-Uffreduzzi, G. 1888 Ueber die Aetiologie der "Meningitis cerebro-spinalis epidemica". Z. f. Hyg., 4, 67-93.
110. Foote, M. 1895 News, 66, 320.
111. Foshay, L., and Mayer, O.B. 1936 Viability of Bacterium tularense (Pasteurella tularensis) in human tissues. J. Am. Med. Assoc., 106, 2141-2143.
112. Fox, J.P. 1948 The long persistence of Rickettsia orientalis in the blood and tissues of infected animals. J. Immunol., Virus-Res. and Exptl. Chemother., 59, 109-114.
113. Francis, E. 1927 Tularemia. Atlantic Med. J., 30, 337-344.
114. Francis, E., and Lake, G.C. 1922 Experimental transmission of tularemia in rabbits by the rabbit louse, Haemodipsus ventricosus (Denny). U.S. Pub. Health Ser. Bull., 1-87, #130.
115. Francis, E. 1932 Duration of viability and virulence of Bacillus pestis. U.S. Pub. Health Repts., 47, 1287-1294.
116. Francis, T., Jr., Brown, G., and Penner, L. 1948 Search for extrahuman sources of poliomyelitis virus. J. Am. Med. Assoc., 136, 1088-1092.
117. Frobisher, M., Jr., Parsons, E.I., Pal, S.E., and Hakins, S. 1947 A simplified method for the preservation of bacteria by desiccation in vacuo. J. Lab. Clin. Med., 32, 1008-1015.
118. Galli-Valerio, B. 1905 Notes de Parasitologie et de technique parasitologique. Centr. Bact., 39, 230-247.
119. Gallo, P., Calderon, T. 1948 El virus de la neumoenteritis de los terneros. Propiddades fisicas, patogenis y cultivo. Bol. Inst. Invest. Vet., 3, 528-537.
120. Galtier, W. 1887 Dangers des matieres tuberculeuses qui ont subi la dessication le contact prolonge de l'eau. Compt. rend. acad. sci., 105, 231.
121. Galvagno, O., and Calderini, A. 1908 Lebensdauer und Virulenz des Typhusbacillus in Gruben, Tonnen, und im Boden. Z. f. Hyg., 61, 185-208.
122. Gärtner, A. 1898 Uber das Absterben von Krankheitserregern im Mist und Kompost. Z. f. Hyg., 28, 1-19.
123. Germano, E. 1897 Die Uebertragung von Infektionskrankheiten durch die Luft. II. Mittheilung- Die Uebertragung der Diphtherie Durch die Luft. Z. f. Hyg. u. Infektionskrankh., 25, 439-452.
124. Germano, E. 1897 Die Uebertragung von Infektionskrankheiten durch die Luft. III. Mittheilung- Die Ueber tragung des erysipels, der pneumonie und anderga streptokokken Infektionen durch die Luft. Z. f. Hyg. u. Infektionskrankh., 26, 66-89.
125. Gernz-Rieux, C., Sevin, A., and Verschoote, G. 1950 The survival in the skin and the spreading through the body of BCG administered by scarification in the guinea pig. Ann. Inst. Pasteur, 3, 103-114.
126. Gilbert, A., and Fournier, L. 1896 La culture du pneumocoque dans le sang defibrine. Compt. rend. soc. biol., 48, 2.
127. Gins, H.A. 1924 Maul- und Klavenseuche. Klin. Wochschr., 3, 1135-1138.
128. Gladin, G.P. 1898 Die Lesensfahigkeit der Pestbacillen unterverschieden physikalischen Bedingungen und der Einwirkung von Desenficientien. Centr. Bakt., 24, 588-591.

129. Gowen, G.H. 1945 Spirocheta in feces. Illinois Med. J., 88, 202-203.
130. Gray, J.D.A. 1932 The significance of Bacterium aerogenes in water. J. Hyg., 32, 132.
131. Green M. 1949 Bacteriology of shrimp. I. Introduction and development of experimental procedures. Food Research, 14, 365-371.
132. Greig, E.D.W. 1913-1914 On the Viability of the Cholera vibrio outside the human body. Indian J. Med. Research, Calcutta, 1, 481-504.
133. Guarnieri, N.I. 1888 Atti della R. Accad. med. di Roma, 4, 97.
134. Gunderson, T. 1932 Germicidal effect of ultraviolet rays on virus of herpes; experimental studies. Arch. Ophthalmol., 8, 519-529.
135. Gurevitch, J., and Delightisch, J. 1947 Survival time of Entamoeba histolytica in feces. J. Palestine Jewish Med. Assoc., 32, 59-60.
136. Haddow, J.R., and Idnani, J.A. 1947 The vaccination of highly susceptible animals against rinderpest. Indian J. Vet. Sci. and Animal Husbandry, 17, 1-10.
137. Hamburger, M., Jr. 1944 Studies on the transmission of hemolytic streptococcus infections. II. Beta hemolytic streptococci in the saliva of persons with positive throat cultures. J. Infectious Diseases, 75, 71-78.
138. Hamburger, M., Jr., and Green, M.J. 1946 The problems of the dangerous carrier of hemolytic streptococci. IV. Observations upon the role of the hands, of blowing the nose, of sneezing, and of coughing in the dispersal of these microorganisms. J. Infectious Diseases, 79, 33-34.
139. Hamburger, M., Jr., Mattman, L.M., Grosch, D.S., and Hurst, V. 1946 Susceptibility to sulfadiazine of hemolytic streptococci recovered in army camps. Am. J. Med., 1, 23-27.
140. Hardy, A.V., Hudson, M.G., and Jordan, C.F. 1929 The skin as a portal of entry in Brucella melitensis infections. J. Infectious Diseases, 45, 271.
141. Hauptmann, W., and Philadelphy, A. 1930 Zur Schädigung des Gonokokkus durch Kälte. Zentr. Bakt., 115, 186-195.
142. Hawley, J.E. 1948 The multiplication of some enteric bacteria in Musca Domestica. Masters Thesis, Univ. of Conn.
143. Hellat, A. 1948 Studies on the self-disinfecting power of the skin. Ann. Med. Exptl. et Biol. Fenn., 26, 1-95.
144. Henderson, W.M., and Brooksby, J.B. 1948 Survival of foot and mouth disease virus in meat and offal. J. Hyg., 46, 394-402.
145. Heppleston, A.G. 1949 Quantitative airborne tuberculosis in the rabbit: the course of human type infection. J. Exptl. Med., 89, 597-609.
146. Herzberg, K. 1933 The destruction of vaccine virus by light, energy and dyes. Z. Immunitats., 80, 507-520.
147. Hettche, H.O. 1937 Zur Atiologie der Rotlaufinfektion. Arch. Hyg., 119, 178-183.
148. Hewlett, R.T. 1909 Disinfection and disinfectants. Lancet, 1, 741, 815, 889.

149. Heymans, J.F. 1927 La survie du bacille de la tuberculose humaine et du BCG dans le corps des bovides. Arch. Internat. Pharmacodyn. et Therap., 23, 225-235.

150. Hill, J.H., and White, E.C. 1933 Action of normal skin on bacteria. Arch. Surg., 26, 901-908.

151. Hoffmann, E. 1926 On syphilitic infection with material from dead bodies and possible parasitic life of *Spirochaeta pallida*. Munch. Med. Wochschr., 73, 185-187.

152. Homes, D., and McClesley, C.S. 1949 Bacteriology of shrimp. V. Effect of peeling, glazing, and storage temperature on bacteria in frozen shrimp. Food Res., 14, 401-404.

153. Horder, T.J. 1913 Bacteriology, pathology and research. Practitioner, 90, 15.

154. Horrocks, W.H. 1906 Report of Commission on Mediterranean Fever. (On the duration of life of *M. melitensis* in unsterilized soil.) Harrison and Sons, London.

155. Horrocks, W.H. 1911 On the viability and possible variation of the *Bacillus typhosus*. J. Roy. Army Med. Corps, London, 16, 225-250.

156. Horstmann, D.M., Ward, R., and Melnick, J.L. 1944 Persistence of virus excretion in the stools of polio patients. J. Am. Med. Assoc., 126, 1061-1062.

157. Howe, A.A., Wen, H.A., Bodian, D., and Maxcy, K.F. 1944 Poliomyelitis virus in the human oro-pharynx. Proc. Soc. Exp. Biol. Med., 56, 171.

158. Huddleson, I.F., Johnson, H., and Hamann, E. 1933 A study of Brucella infection in swine and employes of packing-houses. J. Am. Vet. Assn., 36, 16-30.

159. Hull, T.G. 1947 Diseases transmitted from animals to man. 3rd Ed., Charles C. Thomas, Springfield, Ill.

160. Hussemann, D., and Wallace, M. 1951 Studies on the possibility of the transmission of Salmonella by cooked fowl. Food Res., 16, 89.

161. Jellison, W.L., Kohls, G.M., Butler, W.J., and Weaver, J. A. 1942 Epizootic tularemia in the beaver, Castor Canadensis, and the contamination of stream water with *Pasteurella tularensis*. Am. J. Hyg., 36, 168-182.

162. Jirovec, O., and Peter, R. 1948 Über die Resistenz der Trihoronaden gegen einige Umweltfaktoren. Schweiz. Z. Path. u. Bakt., 11, 146-166.

163. Joe, L.K. 1950 Een eenvoudige, goedkope en doeltreffende methode voor verzending van dysenterie, typhus en paratyphusfaeces naar het laboratorium. Nederland. Tijdschr. Geneesk., 94, 1246-1254.

164. Jordan, E.O. 1926 The changes in the bacterial content of stored normal and typhoid feces. J. Infectious Diseases, 38, 306-322.

165. Kalabuchov, N., and Levinson, L. 1935 Effect of low temperature upon trypanosomes (*Tryp. equiperdum*) in mammals. Nature, 136, 553.

166. Kenwood, H., and Dove, E.L. 1915 The risks from tuberculous infection retained in books. Lancet, 2, 66.

167. Kessel, J.F., and Thompson, C.F. 1950 Survival of *Trichomonas vaginalis* in vaginal discharge. Proc. Soc. Exp. Biol. and Med., 74, 755-758.

168. Keyes, E.L. 1911 Observations upon the persistence of gonococci in the male urethra. Am. J. Med. Sci., 143, 107-117.
169. Kirby, H.J. 1943 Observations on a trichomonad from the intestine of man. J. Parasitol., 29, 422.
170. Kirstein, F. 1905 Ueber die Dauer der Lebensfahrigkeit von Tuberkelbacillen an flugfahrigen Staubchen. Z. F. Hyg. u Infektionskr., 50, 186-214.
171. Koch, R. 1882 Die Aetiologie der Tuberculose. Berlin Klin. Wochschr., 229.
172. Koch, M., and Neisser, A. 1911 Beitrage zur Pathologie und Therapie der Syphilis, Berlin.
173. Kolmer, J.A. 1942 A note on the survival of Treponema pallidum in preserved citrated human blood and plasma. Am. J. Syphilis, Gonorrhea, Venereal Diseases, 26, 156.
174. Kramer, S.D. 1940 Virus of poliomyelitis; survival for over six months in feces of a contact. J. Michigan Med. Soc., 39, 766-768.
174. Kramer, S.D., Hoskwith, B., and Grossman, L.H. 1939 Detection of the virus of poliomyelitis in the nose and throat and gastro-intestinal tract of human beings and monkeys. J. Exp. Med., 69, 49.
175. Krantz, W. 1925 Eine einfache Methode zur Konservierung von Rekurrens Spirochäten. Munchener medizinische Wochschr., 72, 12.
176. Kratzeisen, E. 1923 Ueber postmortale Spirochätenvermehrung in der Leiche. Centr. Bakt.; Abt. 1; Orig., 90, 91-94.
177. Krueger, A.P., Hope, J.W., Rosenberg, L.R., and West, N.S. 1942 Inactivation of influenza virus by human skin. U.S. Naval Med. Bull., 40, 839-846.
178. Krumbiegel, E.R. 1944 Transmission of virus by water. Bull. Hyg., 19, 513.
179. Kuenen, W., and Swellengrebel, N. 1913 Die Entamöben des Menschen und ihre praktische Bedeutung. Centr. Bakt., 71, 378-410.
180. Kusama, H. 1925 Viability of Bacillus Dysenteriae. Philippine J. Sci., 27, 1-7.
181. Lacy, G.R., and Haythorn, S.R. 1921 Viability of Spirocheta pallida in excised tissue and autopsy material. Am. J. Syphilis, 5, 401.
182. Landahl, H.D. 1950 On the removal of air-borne droplets by the human respiratory tract. II. The nasal passages. Bull. Math. Biophys., 12, 161-169.
183. Larson, W.P., and Montank, I.A. 1922-1923 The effect of wetting on the pathogenicity and viability of the tubercle bacillus. Proc. Soc. Exp. Biol. Med., 20, 229-232.
184. Lehmann, K.B. 1931 Das Absterben von Eiterkokken auf Linoleum Holz, Glas, und Gummi unter Berück sichtigung von Licht und Temperatur. Arch. Hyg., 106, 1-31.
185. Leichtenstern, O. 1887 Einiges über Ankylostoma duodenale. Deutsche med. Wochschr.,
186. Lemon, H.M., Wise, H., and Hamburger, M., Jr. 1944 Bacterial content of air in army barracks. Results of a study with especial reference to the dispersion of bacteria by the air circulation system. War Med., 6, 92-101.

187. Lepine, P., Sedallian, P., and Sautter, U. 1939 Sur la presence du virus poliomyelitique dans les matieres fecales et sa longue duree d'elimination chez un porteur sain. Bull. Acad. Med., Paris, 122, 141-149.
188. Levaditi, L., and Vaisman, A. 1946 Duree de conservation de la virulence de treponemes syphilomateux. Bull. Acad. de Med., Paris, 130-224.
189. Levy, E., and Kayser, H. 1903 Uber Lebensdauer von Typhusbacillen, die im Stuhle entleert wurden. Centr. Bakt., 33, 489-495.
190. Lidwell, O.M. 1949 Water content of saliva dried at various humidities. Nature, London, 164, 1012.
191. Liston, W.G. 1924 The plague. Brit. Med. J., 1, 900-903, 950-954, 997-1001.
192. Lofgren, R., and Soule, M.H. 1945 The effect of low temperature on the spirochetes of relapsing fever. I. The viability of four strains of spirochetes stored at -48C. J. Bact., 50, 305-311.
193. Löhr, N.I. 1927 Ueber die Bedeutung des Milieus für das Bakterienwachstum zugleich ein Beitrag über eine Immunisierung gegen Streptokokken und Staphylokokken. Klin. Wochschr., 6, 187-188.
194. Lominski, I., and Thompson, G.R. 1944 Relative sterility of hands of certain metal workers. Brit. J. Indust. Med., 1, 165-167.
195. Lösner, W. 1896 Arb. Reichsgesundh. Amt., 12, 448.
196. Lovell, R., Levi, M., and Francis, J. 1944 Studies on the survival of Johne's bacilli. J. Comp. Path. Therap., 54, 120-129.
197. Lowbury, E.J. 1943 Month. Bull. Min. Health and Emerg. Pub. Health Lab. Serv., 2, 75.
198. Lu, T.H. 1933 Cold weather resistance of contagious bacilli of digestive organs. J. Oriental Med., 18, 865-874.
199. Luckiesh, M., Taylor, A.H., and Knowles, T. 1947 Killing air-borne respiratory microorganisms with germicidal energy. J. Franklin Inst., 244, 267-290.
200. Lu-Ti-Huan 1930 Resistance of contagious bacilli of digestive organs against cold weather. J. Oriental Med., 13, 40.
201. Maccolini, R. 1946 Multiplication potency of various species of coli-aerogenes group in water. Boll. Soc. Ital. Biol. Sper., 22, 919-920.
202. McCormack, G. 1950 "Pink yeast" isolated from oysters grows at temperatures below freezing. Commercial Fish Rev., 12, 28.
203. McCullough, N.B., Eisele, W., and Pavelchek, N.I. 1949 Isolation of Brucella abortus from hogs. U.S. Pub. Health Rep., 64, 537-538.
204. MacFie, J.W.S. 1922 Observations on the role of cockroaches in disease. Ann. Trop. Med., 16, 441-448.
205. MacGreggor, A. 1898 The vitality of the diphtheria bacillus. Lancet, 1, 716.
206. MacKerras, I.M., and Pope, P. 1948 Experimental Salmonella infections in Australian cockroaches. Australian J. Exp. Biol. Med. Sci., 26, 405-470.

207. Maddock, E.C.G. 1933 Studies on the survival time of the bovine tubercle bacillus in soil, soil and dung, in dung and on grass with experiments on preliminary treatment of infected organic matter and the culture of the organism. J. Hyg., 33, 103-117.
208. Malassez, N.I., and Vignal, N.I. 1883 Compt. rend. soc. biol., 366.
209. Manson-Bahr, N.I.
210. Marinelli, G., and Sementini, A. 1947 Survival of bacteria on human skin. Rassegna internaz. Clin. e Terap., 27, 263-266.
211. Maxcy, K.F., and Howe, H.A. 1943 The significance of the finding of the virus of infantile paralysis in sewage. Sewage Works J., 15, 1101-1111.
212. Mayer, E., and Dworski, M. 1924 Studies with ultraviolet light. III. The bactericidal action of mercury-quartz-vapor light irradiation. Am. Rev. Tuberculosis, 10, 166-169.
213. Melnick, J.L., Horstmann, D.M., and Ward, R. 1946 The isolation of poliomyelitis virus from human extra-neural sources. II. Comparison of virus content of blood, oropharyngeal washings, and stools of contacts. J. Clin. Invest., 25, 275-277.
214. Migneco, F. 1895 Einflub des Sonnenlichtes auf Tuberkelbazillen. Centr. Bakt., 18, 729.
215. Migneco, F. 1896 Arch. Hyg., 25, 361.
216. Minett, F.C. 1950 Sporulation and viability of B. anthracis in relation to environmental temperature and humidity. J. Comp. Path. and Therap., 60, 161-176.
217. Mitchell, H.J. 1922 Further studies on ringworm of hands and feet. Arch. Dermatol. and Syphilol., 5, 174.
218. Moiser, B. 1945 Modes of transmission of Hansen's disease. Leprosy Rev., 16, 63-66.
219. Morse, E.V., Kowalczyk, T., and Beach, B.A. 1951 The bacteriologic aspects of experimental brucellosis in dogs following oral exposure. I. Effects of feeding aborted fetuses and placentas to adult dogs. Am. J. Vet. Res., 12, 219-223.
220. Murayama, I. 1929 Resistance of Spirochaeta recurrentis to temperature, light and darkness. Okayama-Igakki-Zasshi, 41, 152.
221. Nasta, M., Jovin, I., and Blechmann, M. 1930 Resistance of filterable forms of tubercle bacilli to action of different factors. Compt. rend. soc. biol., 104, 723-724.
222. Nicholls, L., and Gunawardava, S.A. 1939 The destruction of helminth ova in night soil by composting. Trop. Diseases Bull., 36, 590.
223. Nicola, C. 1891 Sanchez Toledo et Veillon- De la presence du bacille du tetanos, dans les excrements du cheval et du boeuf a l'etat sain. Centr. Bakt., 9, 18.
224. Nicoll, W. 1917 Observations on the influence of salt and other agents in modifying the larval development of the hookworms; Ankylostoma duodenale and Necator americanus. Parasitol., Cambridge, 9, 157-189.
225. Noble, W. 1915 Experimental study of the distribution and habitat of the tetanus bacillus. J. Infectious Diseases, 16, 132.

226. Noguchi, H. 1918 Survival of Leptospira icterohaemorrhagiae in nature; microchemical reactions and intermediary hosts. J. Exp. Med., 27, 609.
227. Nohr, C.O. 1951 Entomological background of the distribution of murine typhus and murine plague in the United States. Am. J. Trop. Med., 31, 355-372.
228. Nolf, L.O. 1932 Experimental studies on certain factors influencing the development and viability of the ova of the human trichuris as compared with those of the human ascaris. Am. J. Hyg., 16, 288-322.
229. Norton, J.F., and Novy, M.F. 1931 Studies on the self-disinfecting power of the skin. Am. J. Pub. Health, 21, 1117.
230. Norton, J.F., and Novy, M.F. 1932 A further note on the disappearance of bacteria applied to the skin. Am. J. Pub. Health, 22, 193.
231. Novikova, E.I., and Lalazarow, G.A. 1934 Viability of plague bacilli in corpses of Citellus pygmaeus. Vestnik Mikrobiologii Epidemiologii-i- Parazitologii, 13, 53-54.
232. Nüssel, K. 1923 Ueber Tuberkelbazillen befund im Stuhl. München. Med. Wochnschr., 70, 357-358.
233. Oag, R.K. 1939 The preservation of Borellia duttoni by freezing. J. Path. Bact., 49, 587-590.
234. Olesiuk, O.M. 1951 Influence of environmental factors on viability of Newcastle disease virus. Am. J. Vet. Res., 12:43, 152-155.
235. Olson, T.A., and Rueger, M.E. 1950 Experimental transmission of Salmonella oranienburg through cockroaches. Pub. Health Repts., 65, 531-540.
236. Ostertag, R. 1908 Z. Infektkr. Haustiere, 4, 1.
237. Ostrolenk, M., Kramer, N., and Cleverdon, R.C. 1947 Comparative studies of enterococci and Escherichia coli as indices of pollution. J. Bact., 53, 197.
238. Ostrolenk, M., and Welch, H. 1942 The house fly as a vector of food poisoning organisms in food producing establishments. Am. J. Pub. Health, 32, 487-494.
239. Parr, L.W. 1937 Sanitary significance of the succession of coli-aerogenes organisms in fresh and in stored feces. Am. J. Pub. Health, 26, 39-45.
240. Parr, L.W. 1938 Organisms involved in the pollution of water from long stored feces. Am. J. Pub. Health, 28, 445-450.
241. Parker, E., and MacNeal, W.J. 1944 Persistence of influenza virus on the human hand. J. Lab. Clin. Med., 29, 121-126.
242. Paul, J.R. 1941 Epidemiology of poliomyelitis. In infantile paralysis: a symposium delivered at Vanderbilt University, National Foundation for Infantile Paralysis, New York, 140.
243. Paul, J.R. 1947 Poliomyelitis in Japan. Am. J. Hyg., 45, 206-218.
244. Paul, J.R., and Trask, J.D. 1939 New Internat. Clin., 3, 59.
245. Paul, J.R., and Trask, J.D. 1940 Poliomyelitis virus in urban sewage. J. Exp. Med., 71, 765.

246. Philip, C. 1948 Observations on experimental Q fever. J. Parasitol., 34, 457-464.
247. Price, P. 1938 The bacteriology of normal skin. J. Infectious Diseases, 63, 301-318.
248. Puntoni, V. 1924 Survival of nonsporogenous bacteria. Policlinico (Sez. Prat.), 31, 219-221.
249. Ransom, A., and Delepine, S. Proc. Roy. Soc., No. 336.
250. Ravitch, M.M., Farmer, T.W., and Davis, B. 1949 Use of blood donors with serologic tests for syphilis- with a note on the disappearance of passively transferred reagin. J. Clin. Invest., 28, 18-23.
251. Rebell, G., Pillsbury, D.M., de Saint Phalle, M., and Ginsburg, D. 1950 Factors affecting the rapid disappearance of bacteria placed on the normal skin. J. Investigative Dermatol., 14, 247-264.
252. Rickard, E.R. 1951 The survival time of the rickettsias of murine typhus in infected flea feces. Am. J. Trop. Med., 31, 306-310.
253. Robertson, O.H. 1947 The dispersal of respiratory pathogens in relation to the occurrence and control of air-borne infections. Am. Rev. Tuberc., 55, 109-123.
254. Rosebury, T. 1947 J. Immunol., 56, 7-96.
255. Rosenthal, S.R., and Elmore, F.H. 1950 Studies on the contagiousness of coccidioidomycosis. II. The fate of spherules in sputum exposed out of doors. Am. Rev. Tuberc., 61, 95-105.
256. Rosahn, P.D. 1935 Infectivity of T. pallidum in excised syphilitic tissue. Am. J. Hyg., 22, 283-291.
257. Rountree, P.M. 1947 Gross infection of wounds in a surgical ward during a trial of the use of oiled blankets. Med. J. Australia, 1, 427-430.
258. Rubino, M.C., and Pedro Seoane. 1929 Infectiousness of meat from animals with foot and mouth disease. Arch. Soc. Biol., Montevideo, 1, 14-22.
259. Rudolfs, W., Falk, L., and Ragotzkie, R. 1951 Contamination of vegetables grown in polluted soil. II. Field and laboratory studies on Endamoeba cysts. III. Field studies on Ascaris eggs. Sewage and Indust. Wastes, 23, 478-485.
260. Sabin, A.B., and Ward, R. 1941 Natural history of human poliomyelitis. II. Elimination of the virus. J. Exp. Med., 74, 519-529.
261. Sanfelice, F. 1893 Untersuchungen über anaërobe Mikroorganismen. Z. Hyg. Infektionskrankh., 14, 339-392.
262. Saunders, G.M., and Scott, V. 1947 Preservation of Plasmodium vivax by freezing. Science, 106, 300-301.
263. Savage, W.G., and Wood, D.R. 1917 The vitality and viability of streptococci in water. J. Hyg., 16, 227-239.
264. Sawers, W.C. 1938 Some aspects of the Leptospirous problem in Australia. Med. J. Australia, 25, 1089-1097.
265. Sawizky, N.I. 1891 Zur Frage uber die Dauer der infektiosen Eigenschaften des getrockneten tuberculosen Sputums. Dissert. Inaug. St. Petersburg.
266. Sawyer, W.A., Lloyd, W.D.M., and Kitchen, S.F. 1929 The preservation of yellow fever virus. J. Exp. Med., 50, 1.

267. Schalk, A.F. 1928 Results of some avian tuberculosis studies. J. Am. Vet. Med. Assoc., 72, 852-864.
268. Schiemann, O., Landau, H. 1919 Über Handedesinfektion und Handereinigung in ihrer Bedentung zur Verhütung von Krankeitsübertragungen. Z. Hyg. Infektionskrankh., 88, 129-184.
269. Schill, N.I., and Fischer, N.I. 1884 Ueber die Desinfection des Auswerfes der Phthisiker. M. Kais. G.A., Bd. 11, 133.
270. Schiller, N.I. 1890 Zum Verhalten der Erreger der Cholera und des Unterleibs typhus in dem Inhalt der Abtrittsgruben und Abwässer. Arbeiten aus D. K. Gesundhtsamte., 6, 197-208.
271. Schofield, F.S. 1927 Effects of temperature on gonococci. J. Urol., 17, 581-591.
272. Schottelius, N.I. 1890 Ueber das Verhalten der Tuberkilbacillen im Erdboden. Deutsche Med. Wochschr., 16, 226.
273. Sellards, A.W., and Hindle, E. 1928 The preservation of yellow fever virus. Brit. Med. J., 1, 713.
274. Shpuntoff, H., and Rosebury, T. 1949 Infectivity of fuso-spirochetal exudates for guinea pigs, hamsters, mice and chick embryos by several routes of inoculation. J. Dental Res., 28, 7-16.
275. Shu-Hsian, C. 1949 Die lebensdauer von Rockettsia in Lausefaeces. Schweiz. Z. Path. u Bact., 12, 508-512.
276. Singer, C., and Arnold, L. 1929 Auto-disinfecting power of the human skin. Proc. Soc. Exp. Biol. Med., 27, 364.
277. Skidmore, L.V. 1932 The transmission of fowl cholera to turkeys by the common house fly, with brief notes on the viability of fowl cholera microorganisms. Cornell Vet., 22, 281-285.
278. Smith, C.R. 1942 Survival of tubercle bacilli. The viability of dried tubercle bacilli in unfiltered room-light, in the dark and in the refrigerator. A m. Rev. Tuberc., 45, 334-345.
279. Smith, C.R. 1942 Survival of tubercle bacilli in books; how contaminated boils may be rendered uninfectious. Am. Rev. Tuberc., 46, 549-559.
280. Smithburn, K.C., Mahaffy, A.F., Haddow, A.J., Kitchen, S. F., and Smith, J.F. 1949 Rift Valley fever. Accidental infections among laboratory workers. J. Immunol., Virus-Res. and Exp. Chemother., 62, 213-227.
281. Soparker, M.B. 1917 Vitality of tubercle bacillus outside the body. Indian J. Med. Res., 4, 627.
282. Sormani, G. 1886 Contribuzione agli sulla storia naturale del bacillo tuberculare. Estr. dal Boll. Scient. No. 1.
283. Sormani, G. 1891 Centr. Bakt., 9, 421.
284. Spector, B., and Buky, F. 1934 Viability of Endamoeba histolytica and Endamoeba coli. U.S. Pub. Health Repts., 49, 379-385.
285. Spector, B.K., and Buky, F. 1934 Viability of Endamoeba histolytica and Endamoeba coli- effect of drying. U.S. Pub. Health Repts., 49, 786.
286. Spink, W.W., and Anderson, D. 1950 Brucella studies on bank blood in a general hospital. A. Agglutinins; B. Survival of Brucella. J. Lab. and Clin. Med., 35, 440-445.

287. Starzyk, J. 1936 Vitalite, toxicite et pouvoir d'immunisation de Rickettsia prowazeki conservees hors de l'organisme du pou, en milieu liquide et en milieu sec. Compt. rend. soc. biol., 123, 1221-1225.
288. Stavitsky, A.B. 1945 Preservation of Leptospira icterohemorrhagiae in vitro. J. Bact., 50, 118.
289. Stein, C.D. 1947 Some observations on the tenacity of Bacillus anthracis. Vet. Med., 42, 13-22.
290. Stenhouse, R., Williams, R., and Hoy, W. 1930 The viability of B. tuberculosis on pasture land, in stored feces and liquid manure. J. Hyg., 30, 412.
291. Sternberg, G.M., and Dezendorf, J.T. 1894 The action of sunlight on microorganisms. Med. Rec., N.Y., 16, 607.
292. Stewart, W., Major 1944 Viability of dysentery bacilli and transmission by flies in North Africa. J. Roy. Army Med. Corps, 83, 42-46.
293. Stewart, A.D., and Ghosal, S.C. 1932-1933 On the value of Wilson and Blair's bismuth sulphite medium in the isolation of B. typhosus from feces and sewage. Ind. J. Med. Res., 20, 341-345.
294. Stone, A.K. 1891 Why the sputa of tuberculous patients should be destroyed. Centr. Bakt., Bd. 10, 106.
295. Strong, R.R. 1942 Prevention and treatment of tropical diseases. 6th Ed., Blakiston, Philadelphia (Stitt's Diagnosis).
296. Sweany, H.C., and MacLane, C.C. 1919 Relation of dust to spread of tuberculosis. Illinois Med. J., 36, 302-305.
297. Swift, B.H. 1937 Trichomonas vaginalis vaginitis as a cause of pruritus vulvae. Med. J. Australia, 1, 123.
298. Tarozzi, G. 1906 Ueber das latent Leben der Tetanussporen im tierischen Organismus. Centr. Bakt., Abt. 1, Orig., 40, 305-311, 451-458.
299. Teague, O., and Barber, M.A. 1912 Studies on pneumonic plague and plague immunization. Philippine J. Sc., 7, 255-268.
300. Theiler, M. 1930 Studies on the action of yellow fever virus in mice. Ann. Trop. Med. Parasitol., 24, 249-272.
301. Thomas, S., and Kreidler, W.A. 1925 The effect of freezing on Eberthella typhi. Abstracts Bact., 9, 25.
302. Tohyama, Y. 1925 Experimental investigations concerning the prevention of epidemic diseases due to aquatic products. Sci. Repts. Govt. Inst. Infectious Diseases, Tokyo, 4, 169-222.
303. Toma, de P. 1886 Sulla virulenza dello sputo tuberculare. Ann. di Med., 275, 3.
304. Tonney, F.O., and Noble, R.E. 1931 Relative persistence of Bact. coli and aerogenes in nature; in decayed stumps. J. Bact., 22, 433-446.
305. Toomey, J.A., Takacs, W.S., and Schaeffer, M. 1948 Attempts to infect amoeba proteus with poliomyelitis virus. Am. J. Diseases Children, 75, 11-14.
306. Topping, N.H. 1940 The preservation of the infectious agents of some of the rickettsioses. U.S. Pub. Health Repts., 55, 545-547.

307. Tovar, R.M. 1947 Infection and transmission of Brucella by ectoparasites. Am. J. Vet. Res., 8, 138-140.
308. Toyoda, H. 1931 Relapsing fever. Nat. Med. J. China, 17, 233-267.
309. Trask, J.D., and Paul, J.R. 1941 Observations on fecal examination in poliomyelitis. Am. J. Pub. Health, 31, 239-244.
310. Trask, J.D., Paul, J.R., and Vignec, A.J. 1940 Poliomyelitis virus in human stools. J. Exp. Med., 71, 751-763.
311. Trask, J.D., Vignec, A.J., and Paul, J.R. 1938 Poliomyelitis virus in human stools. J. Am. Med. Assoc., 3, 6.
312. Turner, T.B., and Brayton, N.L. 1939 Factors influencing the survival of spirochetes in the frozen state. J. Exp. Med., 70, 639-650.
313. Turner, T.B., and Diseker, T.H. 1941 Duration of infectivity of *Treponema pallidum* in citrated blood stored under conditions obtained in blood banks. Bull. Johns Hopkins Hosp., 68, 269.
314. Turner, T.B., and Fleming, W.L. 1939 Prolonged maintenance of spirochetes and filterable viruses in the frozen state. J. Exp. Med., 70, 629-637.
315. Twichell, D.C. 1905 The vitality of tubercle bacilli in sputum. Med. News, N.Y., 87, 642-647.
316. Twichell, D.C. 1906 Vitality of tubercle bacilli in sputum. Trans. Nat. Assn. for Study and Prev. of tuberculosis, 1, 221.
317. Uffelman, J. 1889 Die Dauer der Lebensfähigkeit von Typhus und Cholerabacillen in Fäkalmassen. Centr. Bakt., 5, 497-502.
318. Uhlenhuth, N.I., and Fromme, N.I. 1916 Zur Aetiologie der sogenannten Weil'schen Krankheit (Ansteckende Gelbsucht). Berlin. Klin. Wochschr., 53, 269-273.
319. Vacek, B. 1932 Examination of some conditions necessary for the survival of the typhoid bacillus in water. Casopis Ceskoslov. Lekarnictva, 71, 97.
320. Vasquez-Oolet, A. 1924 Viability of intestinal pathogenic bacteria in fruits and Philippine foods eaten raw. Philippine J. Sci., 24, 35-39.
321. Vidal, C.B. 1934 Viability of tubercle bacilli in tissues and sputum preserved in vitro. Am. Rev. Tuberc., 30, 345.
322. Villemin, N.I. 1869 De la propagation de la phtisie. Memoire Lu a l'Acad. de Med.
323. Welch, H., Ostrolenk, M., and Bartram, M.T. 1941 Role of rats in the spread of food poisoning bacteria of the Salmonella group. Am. J. Pub. Health, 31, 332-340.
324. Wells, W.F. 1921 Seasonal variations in multiplication rate of microorganisms within the body. Am. J. Pub. Health., 11, 636-638.
325. Wells, W.F., and Lurie, M.B. 1941 Quantitative air-borne infection apparatus. Am. J. Hyg., 34, 21.
326. Wenrich, D.H. 1949 Culture experiments on intestinal flagellates. V. Some additional longevity records to September 1, 1949. J. Parasitol., 35, 32.
327. Wenyon, C.M., and O'Connor, F.W. 1917 Human intestinal protozoa in the Near East. London, Wellcome Bureau of Scientific Res.

328. Whitwell, G., and Sutherland, I. 1948 Boils and infected hands: an epidemiological investigation. Brit. J. Ind. Med., 5, 88-92.
329. Winter, C.E., and Sandholzer, L.A. 1946 Studies of the fecal streptococci. I. The isolation of enterococci from natural sources. Fish. Leafl., 201, 1-6.
330. Wood, F.C. 1905 The viability of the pneumococcus after drying: a study of one of the factors in pneumonic infection. J. Exp. Med., 7, 592-625.
331. Wynns, H.C., and Beck, M.D. 1935 Epidemiological studies on relapsing fever in California. Am. J. Pub. Health, 25, 270-276.
332. York, W., and Adams, A. 1926 Observations on Entamoeba histolytica. Ann. Trop. Med. Parasitol., 20, 317-326.
333. Yoshida, S. 1920 On the resistance of Ascaris eggs. J. Parasitol., 6, 132-139.
334. Zeller, H. 1948 Untersuchungen überdas Wachstum des Typhus-bacillus im Harn. Z. Hyg. u. Infektionskrankh, 128, 591-615.
335. Zina, G. 1948 Ricerche sull'Indice microbico cutaneo negli adulti. Giorn. Batteriol. e Immunol., 38, 407-420.
336. Zurhelle, E., and Strempel, R. 1927 Studien uber Lebensfähigkeit und Virulenzerhaltung der Spir. pall. in totem Gewebe. Arch. Dermatol. u. Syphilol., 153, 219-226.

References (Body) Addendum

1a. Anonymous 1921 Thirty-third annual report. Agric. Exptl. Station, La.

2a. Beck, M. Dorothy 1937 California field and laboratory studies on relapsing fever, 60, 64-80.

3a. Bey, M.K. 1948 Effect of absolute humidity of atmosphere on first wave of cholera epidemic in Egypt in 1947. Jour. Roy. Egyptian M.A. 31, 39-72.

4a. Blair, J., Lang, O. 1934 Effect of low temperature freezing on the encysted larvae of Trichlinella spiralis. Studies on muscle of rats, guinea pigs and hogs. Jour. Infect. Dis. 55, 95-104.

5a. Bland, G. and Baltazard, M. 1940 Longevity of virus of murine typhus in excrements of infected fleas. Bull. Soc. Path. Exot., 33, 25-32.

6a. Bloch, O., Jr. 1941 Loss of virulence of Treponema pallidum in citrated blood at 5°C. Bull. Johns Hopkins Hosp. 68, 412-415.

7a. Chick, H. 1912 The bactericidal properties of blood serum., Jour. Hyg., 12, 414-436.

8a. Das, N.B. 1949 Studies on the drying of rinderpest virus. Indian Jour. Vet. Sci. and Animal Husbandry., 19, 5-10.

9a. Dold, H. 1947 Keim-inhibition (Keimvermehrungshemmung) als Mittel der Mikrobienabwehr., Med. Klin., 42, 45-48.

10a. Farley, D.L. 1921 Viability of ringworm fungi in dry cutaneous material., Arch. Dermat. and Syph., 3, 759.

11a. Francis, E. 1914 Laboratory studies on tetanus. Hyg. Lab. Bull., U.S. Pub. Health Serv. 95.

12a. Gould, S., Kassa, L. 1949 Low temperature treatment of pork. Effect of certain low temperatures on viability of trichina larvae., 49, 17-24.

13a. Grubb, I., Laurell, G. Lindquist, K.H. 1947 Spread of typhoid-paratyphoid infections by means of contaminated vegetables. Nor. Hyg. Tidskr., 28, 243-257.

14a. Haagen, E. 1939 Weitere Erfahrungen über die Züchtung und Konservierung des Vakzinevirus. Zbl. Bakt. I. 143, 283-291.

15a. Hampil, B. 1932 The influence of temperature on the life processes and death of bacteria. Quart. Rev. Biol., 7, 172-196.

16a. Jettmar, H.M.v. 1927 Studien über die Vitalitat der Scharlachstreptokokken. Zeitschr. Hyg. u. Infekt., 107, 265-287.

17a. Jungeblut, C.W. 1935 Epidemic menigitis agent of disease and host resistance. Book-Fred.P. Gay. 554.

18a. King, A.G. 1930 Viability of the organism of Rocky Mountain Spotted fever when frozen. Jour. Infect. Dis., 46, 279-284.

19a. Koser, S.A. and McClelland, J.R. 1917 Fate of bacterial spores in animal body. Jour. Med. Res., 37, 259.

20a. Macchiavello, A. 1937 Survival and virulence of frozen and dried Mexican and European Typhus viruses. Rev. Chilena de Hig. y. Med., Prev., 1, 63-68.

21a. Miles, A.A. et al. 1940 Hospital infection of war wounds. Brit. Med. Jour., 11, 855-895.
22a. Miyao, I. 1930 Viability of Spirochaeta Pallida. Phill. Jour. Sci., 42, 199-201.
23a. Neisser 1911 Patholigie und Therapie der Syphillis, Berlin. Arb. A.D.K. Gsudktsamte., 37.
24a. Olitsky, Peter K., Casals, Jordi, Walker, Duard L., Ginsberg, Harold, S., and Horsfall, Frank L. 1949 Preservation of viruses in a mechnical refrigerator at -25°C. Jourl. Lab. and Clin. Med., 34, 1023-1026.
25a. Petri 1921 Quoted by Ravenel in article by Webb.
26a. Ravitch, M.M. and Chambers, J.W. 1942 Spirochetal survival in frozen plasma. Bull. Johns Hopkins Hosp., 71, 299-303.
27a. Remlinger, P. and Bailly, J. 1934 Action of freezing on Rabies virus. Compt. Rend. Soc. de Biol., 116, 407-409.
28a. Research Commission Minsitry Agriculture, Fish. 1927 2nd. Prog. Rep. on Foot and Mouth Dis.
29a. Robinson, Harry M., Jr. 1948 In vitro studies of Microsporon audouini infection of the hair. Arch. Derm. and Syph., 57, 991-997.
30a. Selbie, F.R. 1943 Viability of Spirochete Pallida in stored plasma. Brit. Jour. Exptl. Path., 24, 150-152.
31a. Semple, D. 1911 The relation of tetanus to the hypodermic or intramuscular infection of Quinine. India Govt. Sci. Mem. 43.
32a. Sergent A. 1938 Fievve Recurrente a Spirocheta Hispanicum en Algerie transmission par le Rhipicephale du chien premunition serumde convelescents. Ann. Inst. Pasteur, 61, 217-254.
33a. Sichert-Modrow, I. 1930 Vitality of causative agent of Foot and Mouth disease at various temperatures. Cen. F. Bakt., 119, 17-19.
34a. Smyth, H.F., Pike, E.F. 1921 Disinfecting skins and hair for Anthrax. Amer. Jour. Hyg., 1, 541-555.
35a. Stillman, E.G. 1940 The viability of pneumococci in dried rabbit blood. Jour. Infect. Dis., 66, 171-173.
36a. Stockman, S., and Minett, F.C. 1926 Jour. Comp. Path. and Therap., 39, 1-30.
37a. Turner, T.B. 1938 Preservation of virulent Treponema Pallidum and T. pertenue in frozen state; with a note on preservation of filtrable viruses. Jour. Exptl. Med., 67, 61.
38a. Ungerman 1918 Arb. Kaiserl. Gesundheitsamt. 51, 199.
39a. Urbain, A., Guillot, G. and Vallee, M. 1930-1931 Longevity of Preisz-Nocard Bacillus. Compt. Rend. Soc. de Biol. 105, 676-677.
40a. Webb, G.B., Ryder, C.T., and Gilbert, G.B. 1921 The survival and virulence of Tubercle Bacilli in excised animal lymph nodes. Amer. Rev. Tuberc., 5, 388-396.
41a. Williams, R.S. and Hoy, W.A. 1930 Viability of B. tuberculosis (Bovinus) on pasture land, in stored feces, and in liquid manure. Jour. Hyg., 30, 413-419.

ADDENDUM(BODY)

1a. Abel, R. 1893 Beitrage zur Frage der Lebensdauer die Diphtheriebacillen. Centr. f. Bakt., 14, 756-761.

2a. Arguelles, M.V. 1927 Viability of cholera vibrio in various menstrua. Rev. Filipina de Med. y Farm., 18, 137-140.

3a. Barrat, J.O.W. 1904 Centrifugalisation and Disintegration in relation to virus of rabies. Centr. Bakt., 35, 769-795.

4a. Belin, M., Mutermilch, S., and Salmon, E. 1933 Effect of protective substances on heat resistance of certain bacteria. Compt. Rend. Soc. de Biol., 164, 1278-1281.

5a. Eichorn, H. 1893 Beiträge zum Kenntniss des Einflüssen vom temperatur und Witterungsverhaltnissen auf die tenacitat des Tuberkulosen Sputums.. Jena, B. Eugan.

6a. Hall, I.W. and Fraser, A.D. 1921 The pH range for staphlococcus. Brit. J. Exp. Path., 2, 242.

7a. Hampp, E.G. 1951 Preservation of viability and pathogenicity of the Nichols rabbit strain of Treponema pallidium by freeze drying. Publ. Health Rep., 66(16), 501-506.

8a. Jacotot, H. 1926 Vitality of Pasteurella of hemorrhagic septicemia of animals. Compt. Rend. Soc. de Biol., 95, 1020-1021.

9a. McKinley, E.B., Fisher, R., Holden, M. 1926 Action of ultra violet light upon bacteriophage and filterable viruses. Proc. Soc. Expt'l Bio. & Med., 23, 408-412.

10a. Mc Leod, C. 1949 Preservation and Inoculation studies on Treponema pallidium. J. Ven. Dis. Inform., 30(4), 104-107.

11a. Mc Naught, J.G. 1910 On resistance of E. coli to sunlight and drying. Cent. f. Bact., 53, 326-334.

12a. Perry, W.L. 1948 The cultivation of Treponema pallidium in tissue culture. J.Path. and Bact., 60(2), 339-342.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN CULTURE

TABLE 91 THE SURVIVAL OF BACILLUS ANTHRACIS IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Dark, R.T.	4½ yrs. and 35 yrs., retained full immunizing properties	Novel	1947
Attenuated, 5-10C	Viable and virulent for G.P. after 8 yrs.	Stein	1947
37C, 2 mos. old, dried rapidly	6 hrs.	Swann	1924
LIQUID			
Liquid air	6 hrs. required to kill	Becquerel	1910
Bouillon tubes	2 mos.	Duclaux	1885
Broth tubes, killed with 1% formaldehyde with caporite soln & 1% active Cl	2 hrs.	Hailer	1948
Broth tubes, killed by Chloramine soln with 1% active Cl	4 hrs.	"	"
Bouillon susp., R.T.	10 wks.	Kirstein	1902
Bouillon, 18C, strong wind, direct sun	Inoc. 1,254 Col., Recov. 0, 80 d.	Kruse	1895
Bouillon, 37C, in dark	Inoc. 4,158 Col., Recov. 94, 80 d.	"	"
Liquid air, -185C	No impaired vitality, 20 hrs.	MacFayden	1899
Broth emulsion with unsterilized milk, liquid air	No impaired vitality 7 d.	MacFayden	1900
Liquid H_2, -252C	10 hrs.	"	"
Serum, 37C	69 d.	Panisset	1925
Nutrient, sunlight, air	24 hrs.	Roux	1887
Nutrient, sunlight, no air	83 hrs.	"	"
Bouillon	30 hrs.	Sanfelice	1893
Attenuated spores in N. saline & glycerine, 5-10C	Viable for G.P. after 11-14 yrs.	Stein	1947
Phys. serum with glycerine 20-30C dil. 10^9	114 d.	Velu	1931
" " dil. 10^8	1072 d.	"	"
" " dil. 10^7	1072 d.	"	"
" " dil. 10^6	1877 d.	"	"
Bouillon cult., direct sunlight on paper slips	8 hrs. for bacteria, 5 hrs. for spores	Weinzirl	1914
Liquid air in glass	No change 90 min.	White	1901
SOLID			
Plate cultures	30 hrs.	Arloing	1885
Spores, bouillon, test tube	2 hrs.	"	"
Agar & gelatin plates, exposed to sunlight	1½ hrs. (July, Mar., Aug.) 2½ hrs. (Nov.) 4½ hrs. (winter)	Dieudonne	1894
Agar plates, R.T.	2-3 wks.	Jones	1942
Agar, 37C	18½ hrs.	Launder	1932
Nutrient agar tubes, ozonized air thru tube	No change at 8 d.	Ransome	1901

TABLE C/ THE SURVIVAL OF BACILLUS ANTHRACIS IN CULTURE

Factor(s)	Survival	Reference	
SOLID, (cont'd)			
Agar, incub. temp.	Viable 24 hrs.	Sanfelice	1893
Agar cult. 2-3 days old.	5% incapable of germinating 7 hrs.	Swann	1924
Agar cult. 8 mos. old, kept over fused $CaCl_2$	7 hrs.	"	"
Gelatin agar, 18OC, sunlight for 6 d.	2-6 hrs.	Ward	1892
GENERAL			
80C. (Str. R1009)	Inoc. 234, Recov. 200 after 2 hrs. expos. to alkali	Jones	1942
Best time & temp for heating industrial material suspected infected with anthrax 5 min @ 65C.		"	"
Continuous freezing at -60 to -70C, blood susp.	Organisms destroyed in 90-124 d.	Stein	1947
18 hr. serum broth cult. -5 to-10C.	Viable for G.P. after 10 yrs, 8 mos.	"	"
Boiling	10 min.	Topley	1936

TABLE C.7 THE SURVIVAL OF BACILLUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
B. spp.			
Dried	4-5 yrs.	Proom	1949
LIQUID			
B. cereus			
Broth, before centrifug.	100% survive	Winslow	192[illegible]
" after "	56% "	"	
1 hr. later	71% "	"	
Peptone, before centrifug.	100% survive	"	
" after "	43% "	"	
1 hr. later	53% "	"	
Meat extract, before cent.	100% "	"	
" " after "	51% "	"	
1 hr. later.	57% "	"	
½ Locke-Ringers, before centrifuge	100% "	"	
" " after cen.	3% "	"	
1 hr. [illegible]	1% "	"	
[illegible]			
[illegible]	8-16 min.	Davis	1948
" "	Innoc. 100 million spores, Recov. 0,16 min.	"	
Gentian violet, HgCl₂	Resistant to action	"	
Streptomycin	" "	"	
98.5 F.	12 min. (heat resist)	"	
B. megatherium			
Bouillon cult. direct sunlight on paper slips.	Spores, 6 h.	Weinzirl	1914
Preisz-Nocard bacillus			
Serum in flask, light	11 mos.	Urbain	1930
" " dark	13 mos.	"	
B. radicicola			
Solution	142 d.	Alicante	1926
B. radiobacter			
Solution	10 min	"	
B. subtilis			
High press., 17,600, R.T.	45 min.	Basset	1932
Alcohol & toluol	6 mos.	Hito	1938
Bouillon cult., sunlight	Bact. 8.5 h., spores 5h.	Weinzirl	1914
B. vulgatus			
Bouillon cult., sunlight	5 h.	"	
SOLID			
B. alcaligenes			
Agar, Exp. to UV 30 min.	Acquired slight germicidal properties.	Tanner	1930
B. fluorescens putridus			
Agar & gelatin plates exp. to sunlight	2½ hrs.	Dieudonne	1894
B. megatherium			
Agar covered with sterile 10% cane sugar, 10 C.	8 mos.	Keith	1913
Agar, Exp. to UV, 30 min.	Acquired slight germicidal properties	Tanner	1930

TABLE C 2 THE SURVIVAL OF BACILLUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
SOLID			
B. proteus			
Nutrient agar, 0-5C	No growth	Haines	1934
B. Subtilis			
Agar cov. with sterile cane sugar, -10C	8 [illegible]	Keith	1913
Agar, exp. to UV, 30 min.	Acquired slight germicidal prop.	Tanner	19[illegible]0
GENERAL			
B. megatherium			
-5 to -15C	Resisted better than higher temp.	Campbell	1932
	>27[illegible] d.	Lal	1921
B. mesentericus			
Broth, -13 to -15C	>80 wks.	Tanner	1928
Salt soln., -13 to -15C	>80 wks.	"	"
B. subtilis			
Broth, -13 to -15C	>80 wks.	"	"
Salt soln., -13 to -15C	>80 wks.	"	"
B. globigii, B. thermoacidurans, B. subtilis factors had little if any effect on sporulation. Heat resistant spores were developed. Resistance to phenol and iodine paralleled heat resistance.	Amino acids & growth	Williams	1948
B. brevis, B. subtilis, B. megatherium, B. globigii, B. cereus spore forming bacilli that produce spores of unequal heat resistance. Spores of B. cereus were not affected by any of the amino acids, growth factors, or yeast nucleic acids as nutrients.	Species of aerobic	Williams	1951
B. mycoides			
Bouillon cult., direct sun on paper slips.	Bacteria 6 hrs., spores 5 hrs.	[illegible]	[illegible]
Bacterium linens			
Litmus milk, 20C	Inoc. 152,000,000/ml. 1/ml., 17 d.	Albert	1944
" " R.T.	4 mos.	"	"

TABLE 3 THE SURVIVAL OF BACTERIOPHAGE IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Typhoid, phage			
32% NaCl dehydrated in Raust-Heim apparat.	Viable 26 yrs.	Marcuse	1949
Phage, general			
Dried in vacuo	$3\frac{1}{2}$ yrs.	Campbell	1941
Dried	More resistant to heat	Vedder	193[illegible]
DRIED, LYOPHILIZED			
E. coli and staphylococci			
-78 C. and thawed 20X	Did not lose activity	Sanderson	1945
[illegible] thawing	16% failed to survive	"	
10th "	86% " "		
[illegible] "	99% " "	"	
Dysentery phage			
Addition of 1% gelatin with lyophilized destroyed lytic activity of dysentery phage. Raw egg whites protected phage for inactivating effect of glycogen. Difco yeast, difco brain-heart infusion, fresh aqueous extracts of heart, muscle, liver, pancreas, brain, thymus, & kidney effective in promoting stability of sensitive phage during lyophilization. Lecithin extracted from raw egg yolk gave protection to sensitive phage equal to that afforded by egg yolk itself. Stable on exposure for 48 h. to temp. of 55 C. Passage thru 0.5% HC_1 causes loss of lytic activity. Loss of activity followed dessication. No particular pH favors lytic activity. Addition of cysteine, ascorbic acid & removal of O_2 prior to lyophil. failed to effect stability.		Schade	1944
GENERAL			
Staphylococcus phage			
.01 1% methylene blue, indirect sunlight	5 min.	Clifton	1931
E. coli phage			
2-5 C. (R1)	11 yrs.	Raketen	1947
" (R1 & R2)	7-17 yrs.	"	
Dysentery phage			
Powdered & kept dry, 37 C	No loss in activity after 6 mos.	Schade	1943
Addition of meat, gelatin, dried egg alb., peptone, gastric mucin, human serum & human plasma.	No constant protection for phage	Schade	1944
pH 3.3-4.3, 48 hrs, 18C. Less resistant to same pH at 37 C. in acid med.	Survives	Sierakowski	1930
pH 10-9.55, 24 h, 18 C. More resistant to same pH levels at 37 C.	Survives	"	
More resistant to pH than corresponding organism.		"	

TABLE C 4 THE SURVIVAL OF BORRELIA, LEPTOSPIRA & SPIRILLUM IN CULTURE

Factor(s)	Survival	Reference	
DRIED, LYOPHILIZED			
Borrelia			
-78C (duttoni	1 yr.	Turner	1939
Blood drawn early in disease regains motility better than blood drawn late. (novyi)		Lofgren	1945
-78C. (novyi)	1 yr.	Turner	1939
Rat blood, -12 to -20C (recurrentis)	Infectivity reduced 6 wks.	"	"
Warming from -78C to 0C. over 2-6 hrs. period (swellengrebel)	Kills most of organisms	"	"
-78C (tickmouse)	1 yr.	"	"
Dried from frozen state (vincenti)	192 hrs.	Hampp	1947
Lyophil. vaccine has greater stability than regular liquid vaccine.		Verwey	1950
Leptospira icterohemorrhagiae			
Rabbit testes in infusion broth, -78C	10 mos.	Turner	1939
20% tissue susp. in infusion broth, -78C	Actively motile 10 mos.	"	"
Spirillum minus			
Mouse blood & peritoneal fluid, -78C	Viable for mice, 1 yr.	Turner	1939
LIQUID			
Leptospira icterohemorrhagiae			
Serum Ringers soln., 42C	5 d.	Anjow	1928
Physiol. saline, 29C	20 d.	Reitano	1939
Physiol. saline, variable temp.	8 mos.	"	"
Serum, 37C	6 wks.	"	"
" 30C	3 mos.	"	"
" variable	7 mos.	"	"
.2% guinea pig blood, 30C	16 mos.	"	"

TABLE C 5 THE SURVIVAL OF BRUCELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Brucella, species			
Dried	4-5 yrs.	Proom	194?
LIQUID			
Brucella abortus			
Broth, 15-20 F., dry	400 d.	Feldman	1935
Saline, 62 C.	all dead 1 min.	Seelemann	1938
Brucella melitensis			
Broth	15 d.	Bellelli	1928
Brucella suis			
Aerated broth cult. with dextrose & ascorbic acid. 20-25 C.	2 mos.	Elberg	1947
Brucella, species			
Soln. buffered to pH 7.2	4-5 wks.	Zobell	1932
SOLID			
Brucella melitensis			
Nutrient gel, 22 C.	No change 8 d.	Ransome	1901
GENERAL			
Brucella abortus			
Incub. 30 d. @ 37 D.	Smooth replaced by Smooth X at end of 30 d.	Goodlow	1951
The three smooth types were similar in virulence, antigenic prop. The three differed in resistance to alanine which accumulates in culture fluid. Original smooth type will grow in alanine.		"	
Elevation in temp causes reduction in # of viable cells. Recovery when difference between temp. of ice film & surface of surrounding sample is small. At high moisture % of viable cells is very low. Increase in dryness increases survival after storage. Slow rate of drying increases % viable cells. Recovery of viable cells after freezing-drying low unless NaCl present.		Hutton	1951
2-5 C.	Innoc. 25 b/cc. Recov. 20.2 b/cc, 100 d.	Verwey	1950
Optimum pH 7-7.4		Zobell	1932
Brucella melitensis			
Stored 37 C.	17.3% survival 4 yrs.	Stamp	1947
Brucella, species			
Sunlight and drying	Lowers incidence of disease	Polding	1947

TABLE C6 THE SURVIVAL OF CLOSTRIDIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Cl. novyi	4-5 yrs.	Proom,	1949
Cl. perfringens	3-4 yrs.	"	"
Cl. septicum	3-4 yrs.	"	"
Cl. spp.	4-5 yrs.	"	"
DRIED, LYOPHILIZED			
Cl. botulinum			
Sorenson buffer soln. pH 6.9, frozen with carbon dioxide	±20C for 9 days had no effect on spores, slow or quick freezing had no effect on spores.	James	1933
LIQUID			
Cl. tetani			
Glycerine under high pressure. (13,500 atm)	20% active 45 min.	Basset	1932
Cl. botulinum			
Uninocculated dextrose broth exposed to O_2 for 1 hr.	Recov. 32-81%	Dack	1929
" pH 6.8	Recov. 0-57%	"	"
Unbuffered salt soln.	Recov. 0-37%	"	"
Subcult. in beef heart 100C with 4% peptone	Recov. in 1½-2½ hrs.	Sommer	1930
Above plus PO_4	Recov. in 4 hrs.	"	"
Casein digest	Heat resist. 4½ hrs. Most resistant in 4-8 day cultures.	"	"
10C refrig. foods	Growth only after 27 d.	Tanner	1940
5C "	No growth up to 108 d.	"	"
Glucose, beef infusion broth, heated in water bath 70-73C	10 min.	Thom	1919
10% salt broth, R.T., Lg. # strains ranging from 1-10 not inhibited when in alkaline med.	>49 d.	Wyant	1920
Cl. tetani			
Grown in dextrose bouillon 3 mos.	Viable 2½ mos.	Wesbrook	1896
SOLID			
Cl. tetani			
Sealed agar tubes	38 yrs.	Boventer	1947
Agar, 37C	20-25 d.	San Felice	1893
GENERAL			
Cl. botulinum			
>5F	140 d.	Campbell	1932
100C, moist, 5 hrs., pH 6.8-7.0	Spores destroyed	Tanner	1923
105C, " 2 " "	" "	"	"

TABLE C 6 THE SURVIVAL OF CLOSTRIDIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL (cont.)			
110 C., 1.5 h, pH 6.8-7.0	Spores destroyed	Tanner	1923
115 C., 40 min, "	"	"	
120 C., 10 min., "	"	"	
	Young spores more resis.		
16 C.	14 mos.	"	1931
" in fruits and veg.	>2 yrs.	"	
Direct sunlight, cotton plugged tubes	24-40 h.	Thom	1919
Diffuse light, "	2mos.	"	
100 C.	1 h.	"	
100 C. pH 7.5	Killed 5 h.	Weiss	1921
105 C. "	40 min.	"	
120 C. "	6 min.	"	
	Decrease in thermal resistance as spores age. H ion decreases resistance of spores to heat.		
<u>Cl. fragilis</u>			
37 C.	24-30 h.	Repaci	1910
Regrig.	1 mo	"	
<u>Cl. moniliformis</u>			
37 C.	4 wks.	"	
R.T.	$2\frac{1}{2}$ mos.	"	
<u>Cl. perfringens</u>			
37 C.	3 d.	"	
Refrig.	1 mo.	"	
<u>Cl. tethoide</u>			
37 C.	6 d.	"	
R.T.	6 wks.	"	

TABLE 07 THE SURVIVAL OF CORYNEBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
C. diphtheria			
Dried	4-5 yrs	Proom	1949
C. Magnusson-Holth			
Dried, dark	6 wks.	Ottosen	1945
Daylight	2-4 wks.	"	
C. pyogenes	4-5 yrs.	Proom	1949
C. spp.			
Dried	4-5 yrs.	"	
LIQUID			
C. diphtheria			
Bouillon	Recov. o, 24 h.	Abel	1893
Washed serum, dried in daylight	121 d.	"	
Susp. in physiol. salt soln., washed -48 C.	6 mos.	Cordova	1949
2% glycerine, - 48 C.	6 mos	"	
phosphate buffer, - 48 C	6 mos.	"	
Proteose peptone, - 48 C	6 mos.	"	
Old bouillon	1 cult. viab. 6 mos.	Kasansky	1899
Bouillon susp. from diph. memb., R.T.	Innoc. 100,000 col., recov. 0, 21 h.	Kirstein	1902
" in daylight	24-48 h.	"	
Bouillon susp., R.T., cellar	5 d.	"	
Bouillon	523 d. (Bombay Str.)	Lal	1921
Broth emuls., unster. milk, liquid air,	No impaired vitality 7d	MacFayden	1900
Liquid hydrogen, -252 C.	10 h.	"	
Physiol. saline, r.t., absolute drying over sulfuric acid in vacuo	Innoc. blood or serum agar. Viable for mos.	Otten	1930
Sensit. with Met. violet	Recov. 0, 5 min.	Philibert	1926
Pure culture swabs, dark	60 d. Pathogenic 40 h. following isolation. Pathogenic 50 hrs. following dessic. with light.	Schofield	1916
Liquid air in glass	Recov. 35% in 2 hrs.	White	1901
C. Magnusson-Holth			
.5% formaldehyde	Killed in 3 h.	Ottosen	1945
C. pyogenes			
Pure culture	30 d.	Kirstein,	1902

TABLE ( ) The SURVIVAL OF CORYNEBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
SOLID			
C. diphtheria			
Gelatine	18 mos. still alive	Abel	1893
Gelatine in dark	331 d.	"	
Agar cult.	7 mos.	"	
Agar cult in dark, R.T.	Still viable 171-172 d.	"	
Loefflers, -23.5 C., old cult., 24 d.	Viable 86 d.	Abel	1895
Loefflers, 23.5 C., old cult. 24 d.	Viable 86 d.	"	
"	Str. 2, no growth 86 d.	"	
"	Str. 8, 2 colonies viable 86 d.	"	
Glycerine agar tubes 37 C., ozonized air aspirated thru tube	No change at end of 8d.	Ransome	190
GENERAL			
C. diphtheria			
Incubator, dried, R.T.	7 mos.	Abel	1893
ERYSIPELOTHRIX RHUSIOPATHIAE			
DRIED			
Dried	4-5 yrs.	Proom	1949
Stored at 37 C.	2.6% survived 4 yrs.	Stamp	1947

TABLE C 8 THE SURVIVAL OF DIPLOCOCCUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
D. pneumoniae			
Dried and formalized with modified gastric mucin	9 weeks, agglutinated; 4 weeks, capsules disintegrated	Bourn	1947
Dried	7-8 yrs.	Lal Kalra	1948
38 C.	6-8 yrs.	Patella	1882
Less than 17 C.	4-5 yrs.	Proom	1949
DRIED, LYOPHILIZED			
D. pneumoniae			
Dried, frozen, plain broth	3 yrs	Stillman	1941
"	Type 1, recov. 42% 3 yrs.	"	
"	" 2, " 69% 3 yrs.	"	
"	" 3, " 62% 3 yrs.	"	
"	" 8, " 72% 3 yrs	"	
Dextrose agar	> 3 mos.	Swift	1921
LIQUID			
D. pneumoniae			
Broth, saliva or 0.5% saline susp. RH 50%	high mortality	Dunklin	1948
Physiol. saline, R.T., abs. drying in vacuo.	Innoc. on blodd or serum agar. Viable mos.	Otten	1930
Sensit. with Met. violet	Recov. 0-15 min.	Philibert	1926
36-38 C. with Hb.	50-60- d.	Rymowitsch	1902
Beef bouillon	36 h.	"	
"T" med. with 2 vol. 15% gel. in phys saline, ice-box temp.	> 6 mos.	Truche	1912
Blood with glucose or serum broth, ice box, hermetically sealed	several mos.	Yourevitch	1930
SOLID			
D. pneumoniae			
1 part nutrient agar and 5 parts sterile ascitic or pleuritic fluid.	Short incubation > 3 mos.	Wadsworth	1903
Stock agar cult. covered with thin layer rabbit blood.	50 d.	Washbourn	1896
GENERAL			
D. pneumoniae			
37 C.	> 132 d.	Lal	1921
Change in pH from 7.80 to 4.47 from 13 h. to 1h.	Progressive increase in death rate	Lord	1922
80 F., daylight	Type 3, Smooth 5 mos.	Stillman	1940
110 C., dry	30-60 min.	Yesair, J	[illegible]
56 C., moist	< 60 min.	"	

TABLE C 9 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Dried in dessicator	510 d.	McNaught [illegible]	1910
Dried	4 5 yrs.	[illegible]	[illegible]
Vacuum dried, 195 C.	4 d.	[illegible]	1912
Air dried, dark	4 d	"	
DRIED, LYOPHIL			
Susp. in broth, -185 C. Frozen and thawed 12 times	Inoc. 180,000,000 Recov. 40 000	Rivers, T.	1927
LIQUID			
Saline susp. 6-11 C., RH 70 85%, CO_2 5-4%	[illegible]	[illegible]	1931
1% glucose or lactose in ½% Witte peptone & ½% di potassium in dist. water	Inoc. 100,000 000 after 24 hrs, recov 0. 5 d.	Burling	1918
Dextrose bouillon. Freezing vacuum dessic., freeze 47 h. Culture age 48 hrs.	[illegible] d.	[illegible]	[illegible]
Above with culture age 24 h. freezing 24 h	57 d.	"	
Bouillon culture 5 C	Inoc. [illegible],000,000/cc Recov. 190,000,000/cc in 62h. Inoc. 15,000,000/cc Recov 1500/cc, 1 3/4 h Inoc. 14,500,000/cc Recov 7 000/cc, 2¼ h.	Heiberg	1932
Glucose soln -6 C.	0% dead	Hilliard	1918
Glucose, tap water, 10 C	[illegible] hrs.	"	
Glucose soln -0.5 C	3 Hrs.	"	
" -1.5 C	3 Hrs	"	
" 6 C	3 hrs. Rapid destruction of 90% or more when frozen in tap water for 3 hrs.	"	
M/15 PO_4 buffer 2 C., irrad. O_2 tension lowered	Showed 1/3 sensitivity when oxygen tension lowered by saturating with N_2 or CO_2. Protect. given by adding glucose or addition of cysteine	Hollander	1951
Sterile buffer soln 15,5 C. With ultra sonorator	Kill 80%, 10 min. " 90%, 15 min. " 99%, 40 min	Horwood " "	1950
3% soap soln., 4-8 C.	6 h.	Jolle	1895
2% " " "	[illegible] h.	"	
8% " " 28 & 30 C.	30 min	"	
6% " " "	1 h.	"	
3% " " "	6 h	"	
1% " " "	24 h	"	

TABLE C 9 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference
LIQUID (Cont.)		
Buffered media, 5 C.	Maximal survival	Jordan 1948
pH 6.5-6.6	610 min. 90% mortality	"
pH 7.0-6.4	abnormally sensitive	"
pH 2.8	99% mortality [illegible] 12 min	"
.85% NaCl, -252 C	3 h	Kadisch 1931
NaCl soln	Still recoverable 6 wks	Karaffa 1912
5.42% C.P. glycerine, 20 C susp. in water	Large % alive 6 mos.	Keith, 19[illegible]
Cultures, R.T., dark in inverted Pastens dish	358 d.	MacConkey 1905
-185 C Liquid air	No impired vitality 20H	MacFayden 1899
Broth emulsion with star milk, liquid air	No impired vitality 7 d	MacFayden 1900
Quill tubes, liquid air	[illegible]	"
Liquid H_2, 252 C, sealed	10 h	"
Lactose peptone water	5-78 d	Oshii 1920
Serum, 37 C.	30 d	Penisset 1925
Sensit with met. violet	Recov. 0. 2 h	Philibert 1926
Saline, 78 C, Freeze in CO_2 ice.	21.5%	Proom 1949
Broth " " "	52%	"
Broth, R.T.	43.3%	"
Saline, -78 C.	64.6 %	"
Ringers soln., pH 2	Recov 1% 4 h	Shaugnessy, 1925
" " 6	" 198% 4 h.	"
" " 8	" 65% 4 h.	"
" " 11	" 0% 4 h.	"
NaCl soln 1.45 M pH 2	" 2% 4 h.	"
" pH 6	" 65% 4 h	"
" " 8	" 0% 4 h.	"
" " 11	" 0% 4 h	"
NaCl soln .725 M pH 2	" 0% 4 h	"
" pH 6	" 61% 4 h	"
" " 8	" 4% 4 h.	"
" " 11	" 0% 4 h.	"
NaCl soln .0145 M, pH 2	" 1% 4 h.	"
" pH 6	" 88% 4 h.	"
" " 8	" 50% 4 h	"
" " 11	" 0% 4 h	"
CaCl soln 1.45 M, pH 2	" 0% 4 H.	"
" pH 6	" "	"
" " 8	" "	"
" " 11	" "	"
Balanced salt soln may be distinctly favorable to bact. viab. in water at optimum react. while distinctly unfav. in slightly more alk. soln. Acid soln. kills rapidly. Neutral pH favors viability		"

TABLE C 4 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, (Cont.)			
NaCl Soln	Buffering capacities reduced with all strengths used	Shaughness, 192[illegible]	
$CaCl_2$ soln	Buffering capac. partial abolished in all solns which were non toxic at favorable pH.	"	
NaCl and $CaCl_2$	Showed no material inc. to buffering capac over that of the soln cont $CaCl_2$ alone	"	
NaCl soln	Still recoverable 6 wks	Stadler	19[illegible]
Broth, 13 to 15 C	Recov 1% 8 wks	Tanner	19[illegible]
Salt soln "	" 1% 12 16 wks	"	
10% sucrose susp, 19.5 C	Inoc 6,000,000/ml 48.6% reduct, 2½ h.	Weiser	1946
" denitrified "	Inoc 6,000,000/ml 55.1% reduct, 2½ h	"	
" crystallized "	Inoc 10,000,000/ml 3[illegible].0% reduct 2 h.	"	
Peptone buffer mix 19.5 C pH 7.0, susp 20 h cult	Death slow and difficult to detect, 10 h	Weiser,	1945
Broth, before centrifug	100% survival	Winslow	1927
" after "	70% "	"	
" 1 h after "	70% "	"	
Broth cult mixed with sea sand, 69 C, RH 90%	8 h	Winslow	1911
Above with RH 22%	10 h	"	
Above, temp 70C, RH 60%	7 h	"	
Above, temp. 69C, RH 90%	8 h	"	

TABLE C 4 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference	
SOLID			
Raw milk on 1% lactose agar & added to litmus milk, incub. 15 d. @ 20 C.	Generation time lengthened	Allen	1923
Agar & gelatin plates, exposed to sunlight Nov.	1½ H. (March, July, Aug) 2½ h (Nov.) 4½ h. (Winter)	Dieudonne	1894
Salt media	91 d.	Frank	1940
Nutrient agar. R.T stored in dark	Many viable cells 14 yrs	Sears	1946
Agar exposed to U.V. 30 min.	Acquired slight germicidal power	Tanner	19[illegible]
Agar " " X ray	C-9 mutant strains produced	Tatum	19[illegible]
Nutrient agar with Na. 37 C	Less toxic than Ca. Mixt of Ca and Na less toxic and Bact. inc.	Winslow	19[illegible]
$CaCl_2$ 0.00145 M	Recov. 152% 24 h	Winslow	1923
NaCl 0.0145 M	Innoc 100%. Recov 140% 24 h	"	
Gelatin 20 C.. 1% acid add to phenolphthalein	> 11 mos	Worth	1919
GENERAL			
Cells of E. coli were found to remain dormant for 16 d. 85% develop in 48 h.		Burke	1925
Heat shocked 30 min. 53 C Temp	Innoc 1,467,000, Recov. 120,000, 38 hrs.	Elliker	1938
" 28 C.	Innoc 1,674,000, Recov. 570,000, 37 h.	"	
" 30.5 C	Innoc 1,510,000, Recov. 427,000, 42 h.	"	
" 38.5 C.	Innoc 1,341,000, Recov. 875,000, 20 h.	"	
" 40 C	Innoc. 1,413,000, Recov. 267,000, 10 h.	"	
Culture med. (1½-3 yrs old) 100 following growth at 45 C	95% reduction in 1 h. due to temp. change	Hegarty	1940
Susp E. coli, hem strep., & acid fast saprophytes heated various lengths of time. Inc. in counts greatest in plates heated longest. Greatest inc in E. coli and strep 24 48 h		Isaacs	1930
Growht in culture	1,562 d.	Lal,	1925
Desicated	Death proceeds logarythmically	Heller	1941
In fluid state	Viable for longer periods than when dessic.	"	

TABLE C 4 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference	
GENERAL			
Dist. water, saline, salicin, tryptophane, glucose, xylose, sucrose	% reduction in dessic. microorganisms changes from 83.8% to 8.0% in 1 d. With similar cpds. in fluid control, the % reduct. changed from 33% to 6.0%	Heller	1941
Variation of resistance in relation to age of cult.	Ratio drops in 2 hrs. then climbs and reaches maximum of 1 at 8 hrs.	Regnier	1938
60 C.	30 min.	Ruska	1941
100 C., broth, dist. water, dried on collodion film.	Viable 1 h.	Ruska	"
62 C., watery medium	1 h.	"	
5-7 C.	24 h.	"	
Liquid air, -183 C.	-	"	
-78 C., thawed 20 times	Did not lose activity	Sanderson	1925
45 C., changes suddenly to 10 C.	95% reduction, 1 h. Not affected when changes in temp. take place gradually	Sherman	1934
Young cells, 1 C.	Inoc. 8,600,000, Recov. 0, 42 d.	"	1942
Mature cells, 1 C.	Inoc. 650,000,000, Recov. 10,400,000, >62 d.	"	
Stored at 37 C.	12% survive 4 yrs.	Stamp	1947
8 C. rise in temp. at a given conc. NaOH	K inc. by 35-109%	Watkins	1932
Double conc. of NaOH	Increases K 10 times	"	
Lime treatment, pH 9-9.5	>540 min.	Wattle	1943
" " " 9.5-10.0	>600 "	"	
" " " 10.0-10.5	>600 min.	"	
" " " 10.5-11	>600 "	"	
" " " 11-11.5	>300 "	"	

Rate of storage death at the higher freezing temp. is very rapid & is much greater at the temps. above -30 C. than -30 C. & below. Repeated freezing more lethal than simple freezing or storage in frozen state for similar intervals of time. Freezing much more lethal than supercooling. Repeated fluctuations of temp. of frozen susp. between -30 C. & -78 C. appear to result in lower mortality than storage at either temp. but this protective effect not noted at temp. ranges above -30 C. nor below -78 C. Immediate death occurs at a brief stage in freezing process during which extracellular ice formation is being completed. Mortality due to immediate death does not vary with intensity and freezing time. Rate of storage death at higher freezing temps. is rapid at temps. above 30 C. than less than 30 C. Repeated freezing is more lethal than single freezing or storage in frozen state for intervals of time.

TABLE C9 THE SURVIVAL OF ESCHERICHIA COLI IN CULTURE

Factor(s)	Survival	Reference	
GENERAL			
Stored at -1.5 C.	99.3% reduct. 180-210 min.	Weiser	1945
" -15 C.	85.2% " 120-225 min.	"	
" -30 C.	55.3% " 225-270 "	"	
" -78 C.	47.6% " 270-315 "	"	
" -195 C.	39.7% " 285-330 "	"	
Fluctuated at -1.5 to -15 C. 35 times.	98.4% " 180 min.	"	
Fluctuated at -15 to -30 C. 44 times.	57.0% " 220 min.	"	
Fluctuated at -78 to -195 C. 46 times.	50.8% " 220 min.	"	
Acid action on microorganisms is specific		Yaoi	1924
-78 C., thawed 20 times	Did not lose activity.	Sanderson	1925

TABLE C10 THE SURVIVAL OF MICROORGANISMS IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Alcaligenes, spp.			
Dried	4-5 yrs.	Proom	1949
Aerobacter, spp.			
Dried	4-5 yrs.	"	
Hemophilus			
Dried (spp.)	4-5 yrs.	"	
" (pertussis)	"	"	
Klebsiella			
Drying	months	Loewenberg	18??
Dried	4-5 yrs.	Proom	1949
Lactobacillus			
Dried (spp.)	3-4 yrs.	Proom	1949
" 30-37 C. (bulgaricus)	Became inactive in short time	Rogers	1914
Proteus spp			
Dried	4-5 yrs.	Proom	1949
Pseudomonas			
Dried(spp)	4-5 yrs.	"	
Dried in vacuo(pyocyaneus)	Still alive 4 mos.	Shattock	1911
DRIED, LYOPHILIZED			
Lactobacillus bulgaricus			
10 cc. milk. Freeze dry in vacuo, 3-4 hrs.	90-110%	Rogers	1914
Pseudomonas aeruginosa			
Frozen, -24 C., thawed repeatedly at 25 C.	35.6% mortality 1st freezing.	Stille	1943
LIQUID			
Aerobacter aerogenes			
Peptone and water susp. spray dried	Recov. 1%	Bullock	1947
Freeze dried, peptone & water susp.	Recov 10%	"	
Flavobacterium spp.			
5 to 15 F.	Recov. 0, 77 d.	Campbell	1932
Hemophilus influenza			
Blood broth, 15 C.	$2\frac{1}{4}$ h.	Ononato	1902
" " -20 C.	$1\frac{1}{2}$ h.	"	
Klebsiella			
Serum, 37 C.(Friedlanders)	43 d.	Panisset	1925
Lactobacillus			
Broth emulsion with unster. milk, liquid air, (acidophilus)	7 d.	MacFayden	1900
Liquid H_2, -252 C.	10 h.	"	
NaCl susp., -10 to -80 C. (acidophilus)	Undiminished count	Mejlbo	1941
.85% NaCl (acidophilus)	Decreased little in 3 d.	Zeug	1920
Milk & lactose, 40-43 C. (bulgaricus)	Innoc. 1 X 10^9/ml. Recov. 100 X 10^9/gm.	Rogers	1914

TABLE C/10 THE SURVIVAL OF MICROORGANISMS IN CULTURE

Factor(s)	Survival	Reference	
LIQUID			
Lactobacillus casei			
Nutrient broth	Rapid freezing caused less injury than slow freezing	Lund	-
Proteus vulgaris			
NaCl soln.	3 wks.	Karaffe	1912
Liquid air, -185 C.	No impaired vitality 20h.	MacFayden	1899
Broth emulsion with unster. milk, liquid air,	No impaired vit., 7 d.	"	1900
Liquid H_2, -252 C.	10 h.	"	
Pseudomonas pyocyaneus			
24 h. peptone water cult., vacuum dried	7 mos. & 7 d.	Shattock	1912
24 h. peptone water cult., air dried	4-6 d.	"	
SOLID			
Achromobacter, spp.			
Nutrient agar, 0 C.	Rapid growth, 5 d.	Haines	1934
Aerobacter spp.			
24 h. agar cult. in dist. water on filter paper in dry incubator, 37 C.	Alive 31 d.	Hastings	-
Above with milk cult.	Alive 96 d.	"	
Dry corn starch, R.T.	3½ yrs.	"	
Azotobacter chroococcum			
Dextrine agar, dried	10 yrs.	Omeliansky	1926
Hemophilus pertussis			
Agar, 20 C.	8 mos.	Worth	1919
Lactobacillus bulgaricus			
-	>657 d.	Lal	1921
Malleomyces mallei			
Glycerine agar tubes, 37 C. ozonized air aspir. thru tubes.	No change at end of 10 d.	Ransome	1901
Proteus vulgaris			
Agar, 10% sterile cane sugar soln., -10 C.	8 mos.	Keith	1913
Pseudomonas			
Agar, covered with 10T sterile cane sugar, -10 C. (fluorescens)	8 mos.	"	
Agar, full radiation of Hg. arc. (pyogenes)	1 h. at 5 cm. 15 min. at 8 cm.	Fazzoni	1914
Nutrient agar, 0 C. (spp.)	Rapid growth, 5 d.	Haines	1934
GENERAL			
Aerobacter aerogenes			
Excess lime, pH 9.5-10	>6 min.	Wattle	1943
" " " 10-10.5	>600 min.	"	
" " " 10.5-11	>540 min.	"	
" " " 11-11.5	>600 min.	"	
Erwinia amylonora			
Exudate, 16 C., RH 0-45%	22 d.	Rosen	1938

TABLE C10 THE SURVIVAL OF MICROORGANISMS IN CULTURE

Factor(s)	Survival	Reference	
GENERAL			
Erwinia			
Combinations of moderate temp. & moderate or high humidities proved conducive to short life. Equally high temp. with low R.H. made for long life when organisms in exudate.		Rosen	1938
Hemophilus influenza			
Blood agar slope, 37 C.	>132 d.	Lal	1921
Physiol. NaCl soln., R.T. sealed tubes. Absolute drying over sulfuric acid in vacuo	Viable for mos.	Otten	1930
Klebsiella			
Stock lab. cult., R.T., sealed tubes.	12-13 yrs.	Ahuja	1935
Malleomyces mallei			
Vacuum, 1-4 C.	25 mos.	Velu	1942
Proteus spp.			
Stock lab. cult., R.T. sealed.	19 yrs.	Ahuja	1935
14-30 C.	103 d.	Hilliard	1918
(P. morgagnii)	1,562 d.	Lal	1925
None given	"	"	
Pseudomonas			
(Aeruginosa) Freezing 50 h. cult. age 24 h.	17 d.	Hammer	1911
(Pyocyaneous) Excluded from light	3 mos.	Shattock	1911
Excess lime, pH 9.5-10	>420 min.	Wattle	1943
" " " 10-10.5	>300 min.	"	
" " " 10.5-11	>240 min.	"	
" " " 11-11.5	>120 min.	"	

TABLE C // THE SURVIVAL OF MICROORGANISMS IN CULTURE (GENERAL)

Factor(s)	Survival	Reference	
LIQUID			
Broth or dist. water, -16C.	Shorter than in sea water.	Hess	1934
-185 C.	No impairment of vitality, 20 h.	MacFayden	1899
Horse serum, vacuum over phosphorus pentoxide.	83% viable 14 yrs.	Rhodes	1950
SOLID			
Nutrient agar, 22 C., pH 7.2	103 colonies	Brown	1930
Nutrient agar slants, 37 C. or 30 C. with 572-25,320 R. X-ray.	Order of decreasing resistance: Staph. aureus, E. coli, A. aerogenes, S. marcescens, Ps. aeruginosa, P. fluorescens.	Fram	1950
Greatest in resistance observed with readily absorbed cations.		Harris	1949
Petroff medium, bottles evacuated, left in ice box.	11 mos. (acid fast)	Harris	1933
GENERAL			
Spring temp	< 40 d.	Duclaux	1885
Summer temp.	< 20 d.	"	
Dried organisms more resistant to high temp.		Flosdorf	1938
Slow freezing allows conc. of salts & protein deactivation.		Greaves	1944
Destruction of microbial forms at -10 C. faster than at -20 C. compares favorably with other reports.		Haines	1934
Resistance to U.V. light lower in non-pigmented microorganisms than in those producing pigment but not excreting it into medium. Carotenoids have protective effect. Microorganisms excreting pigment to medium are as sensitive to U.V. as colorless org.		Imshenetskii	1946
Low temp alone does not destroy bacteria but appears to favor longevity.		Keith	1913
Storage temperature approaching 0 C. results in a greater decrease in bacterial numbers than that observed at lower temp.		Kiser	1942
120 C. steam is effective in sterilizing spores of soil bacteria		Konrich	1935
28 C., sea water	4 d.	Lipman	1926
Organisms survive equally well at temp. colder than solid CO_2. Survive temp. ranging from that of liquid oxygen (-183C) to that of liquid He (-296 C.) In rapid freezing the water in the cell is not changed to ice crystals but to a glass-like amorphous mass & this results in less injury than freezing at slower rates.		Luyet	1938
Most organisms live longer under sterile paraffin oil.		Morton	1938

TABLE 211 THE SURVIVAL OF MICROORGANISMS IN CULTURE (GENERAL)

Factor(s)	Survival	Reference	
GENERAL			
23 cultures enteric bacteria from suspected food preserved on nutrient agar.	Original character unchanged 11-37 yrs.	Pergola	1950
Death during storage is a function of storage temp. Moisture presence most important factor contributing to loss of viability. Presence of O_2 deleterious. Dry nitrogen atmosphere superior. Survived best when protective colloids such as serum & broth used. Survival lowest in saline. Young cultures more resistant to drying.		Proom	1949
Viable in frozen fruits after 3 yrs. at 15 F. Agar slants held at 16 F. for 1 yr.		Smart	1935
7-10 C. below optimal temp.	Maximum tolerance observed.	Van Eseltine	1949
High temp. resulted in spores of increasing resistance in peptone water with added salts of magnesium phosphate		Williams	1929
Sodium favors viability but toxic in high conc. Calcium opposite effect of sodium in low conc. Pb & Hg, though toxic, stimulate viability in high dilution.		Winslow	1928
Marine bacteria very sensitive to heat		Zobell	1939
Cult., -15 C.	160 wks.	Tanner	1928

TABLE C/2 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
M. tuberculosis			
Frozen culture, dessicated, refrigerator	3 yrs.	Cohn	1939
Natural cultures	6 mos.-1yr.	"	
Incubator, dessicated	"	"	
Drying	Shortens viability	Corper	1923
17 years dessication in vacuo on Lowensteins or Dubos medium	9 strains, none grew	Frobisher	1949
Petroffs medium, in evac. bottle in ice box 11 mos.	10 strains, 11 mos.	Harris	1933
Dessicated in vacuo	17 yrs.	Frobisher	1949
Dried	4-5 yrs.	Proom	1949
LIQUID			
M. tuberculosis			
NaCl soln., 0.9%, inject into guinea pig	24-31 d.	Bartel	1908
NaCl soln., 0.9% 2 h. after g.p. inoc.	43 d.	"	
" 8 h. after inoc.	29 d.	"	
" 24 h. " "	100 d.	"	
" 48 h. " "	88 d.	"	
Old culture	43 d.	"	
Dist. water and glycerine inject into G.P.	13 d.	"	
" after 2 d.	-	"	
" " 33 d.	155 d.	"	
Potato with glycerinated bouillon susp. in Lowensteins med. 1 C.	567 d.	Boquet	1943
Petroffs gentian violet and egg.	Viable 4-8 mos.	Corper	1923
Buffered isotonic coln. pH	7		
Temp. 60 C.	few min.	"	
" 50 C.	5 h.	"	
" 45 C.	8 d.	"	
Broth, whole egg, 50 C.	5 h.	"	1938
" " 55 C.	1 h.	"	
" " 60 C.	15 min.	"	
Petroffs gentian violet or 5% glycerol agar in icebox or incubator	4-8 mos.	"	1923
Physiol. saline, 5-10 C.	Alive and virulent >1 yr.	Feldman	1932
Saline susp. -76 C. frozen, dried	>6 mos.	Glover	1946
Dorsets	6 yrs.	Gloyne	1920
Purified casein and glycerol, 37 C.	2 yrs.	Hastings	1923
.85% NaCl, -252 C.	50 h.	Kadisch	1931

TABLE C/2 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference
LIQUID, CONT.		
M. tuberculosis		
Bouillon, R.T., Petri dish	5 d.	Kirstein 1902
Liquid air in steel tube, -30 C. Stored in dark ice box. (Avian)	No growth after 6 yrs.	Kyes 1939
-192 C., liquid air (Avian)	Did not destroy all viable bacilli but decreased rate of surviving bacilli multiplicat. in culture & produced TB in animals	"
Stored daily for 21 hrs. in CO_2 bath	All animals showed t in spleen following infection	"
Culture stored 6 yrs.	Inj. into rabbits (4cc) All died 3-4 wks.	"
-3 C. in PO_4 soln.	F[illegible] show any effect [illegible] wk. old chidks. Lost pathogen. after 1h, R.T.	"
200 X alternate freezing in liquid N_2 (-195 C.) and thawing in water at 34-36 C.	Still showed some viable organisms	"
Egg medium	Growth	Larson 1922
1% castor oil, soap soln.	No growth	"
0.8% NaCl soln.	3 d.	Moriya 1909
Beef decoction	9 mos.	"
glycerol bouillon	9 mos.	"
.8% NaCl 37 C.	98 d.	"
.8% " ice box	152 d.	"
Beef broth infusion, ice box	156 d.	"
Glycerin bouillon, ice box	156 d.	"
Glycerine agar, 37 C., sealed and incub. (Avian)	Viable 20 d. Non-viable 30 d.	Potter 1939
Glycerine agar, 37 C. culture, 2-4 wks. sealed in glass (human)	Infectious power retain	"
Glycerine agar cult. 38 C. glass sealed, incub. (bovine)	Loss of infect., 2 mos.	Potter 1942
Hohn, Lowenstein, Petragnani deprived of O_2, stored in dark. 2-5 wks. (human)	Non-viable 1 mo.	"
.85% NaCl	800 d. does not infect guinea pig	Pugnani 1929
Glycerine agar tubes with ozonized air, 37 C.	No change in 10 D.	Ransome 1901

TABLE C/2 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, CONT.			
M. tuberculosis			
Physiol. saline soln. .85%, near freezing	310-330 d.	Shope	1926
Lymph node emulsion in salt soln.	87 d.	Webb	1921
Egg	30-50 min.	Weinzirl	1907
SOLID			
M. tuberculosis			
Glycerol agar, 37.5 C.	4-8 mos. (max. 16 mos)	Cooper	1923
Glycerol "	Dead in 6 yrs		
	(M. phlei dead in 4 yrs)	Gloyne	1920
Petroffs medium in bottle evac., left in ice box 11 mos.	(Human) 11 mos.	Harris	1933
	(Bovine) 11 mos.	"	
	(Avian) 11 mos.	"	
Agar, pH 6.6	Grew well	Isaacs	1930
	Heating decreases # of survivors able to grow during lag phase. Unless grown at pH 7.6 more survivors grew but the lag period was not decreased		
Artificial media	>10 yrs	Karwacki	1928
Solid media in pyrex tube sealed in vacuo	(Avian) viable 8 mos.	Potter	1935
Pyrex tube, R.T., sealed in vacuo	(Str. P4) viable 80 d.	"	
Dark, 37 C.	5 mos.	"	
GENERAL			
M. tuberculosis			
40-50 F.	7-19 mos. Bovine more resistant than human	Cooper	1923
37 C. incub. in glycerol broth	12 yrs, 42% human viab.		
	" 44% bovine viab.	"	
-9.4 to -19.9 C.	Viable 1st 24 h.	Homma	1927
-1.0 to -8.0 C.	Viable 2nd 24 h.	"	
-7.0 to -14.3 C.	Viable 3rd 24 h.	"	
-17.3 to -29.2 C.	Viable 4th 24 h.	"	
-10.6 to -23.9 C.	" 5th "	"	
-13.4 to -26 C.	" 1st 24 h.	"	
-11.5 to -24.3 C.	" 2nd 24 h.	"	
-8.7 to -17.4 C.	" 3rd 24 h.	"	
Below 0 C.	623.5 h.	"	
Above 0 C.	216.5 h	"	
Mixed with quinine	Requires 25 min. exp. to U.V.	Mayer	1924
Deprived of O_2 and H_2O for 24 hos.	Survive as viable pathogens	Potter	1935
Dark, no O_2 R.T., Dessic.	(Str. P4) 2 yrs	Potter	1937
Dark, 37C., H_2 Dessic.	(Str. P7) 1 yr	"	

TABLE 0/2 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL, CONT.			
M. tuberculosis			
Deprival of O_2 kills tubercle bacilli. Rapid dessication favors survival. Avian bacilli at body temp. survive for more than 1 yr. with only trace of O_2 and H_2O while at R.T. they survive 2 yrs.		Potter	1937
pH 2.55	168 h.	Prudhomme	1935
" 1.95	48 h.	"	
" 0.97	24 h.	"	
Nucleic acids have no specific action on tb bacillus. Tb bacillus destroyed by pH <2. Acetic acid has no effect.		"	
100 C.	--	Ruska	1941
Ice box, near freezing	330 d.	Shope	1926
Cult., protected from light	3 wks.	Simmons	1923
Darkness and moisture conducive to prolongation of life, while dryness and thermostat temp. hastened destruction.		Twitchell	1906
2 C.	12 mos.	Vidal	1934
BCG, DRIED, LYOPHILIZED			
5% gelatin, 4 C.	12 mos.	Ungar	1949
" " 26 C.	12 mos.	"	
Sterile serum, 4 C.	12 mos.	"	
" " 6 C.	12 mos.	"	
Lowensteins egg med., 38 C. before freeze drying.	No difference in number of colonies between, before & after.	Van Deinse	1950
Keeps viability in 50% glucose better than lactose, amylase or serum in cylinder with paraffin oil, -50 C.		"	
R.T.	Dimished # living organisms, 20% at end of 1st mo.	"	
Stacked in ice box, 5 C.	No mortality during 1st 3 mos., 10% after 6 mos.	"	
Stored at R.T.	2 mos.	"	
BCG, LIQUID			
Lowensteins egg medium, 1:10 dil., 2-4 C.	2 yrs.	Birkhaug	1951

TABLE 0 13 THE SURVIVAL OF NEISSERIA SPECIES IN CULTURE

Factor(s)	Survival	Reference
DRIED, GENERAL		
Neisseria intracellularis		
Dried on garnets and glass in dark	24 h.	Flugge 1905
Diffuse daylight	10 h.	"
Dark	25 h.	"
Dried	4-5 yrs.	Proom 1949
N. gonorrhea		
Dried	4-5 yrs.	"
N. species		
Dried	4-5 yrs.	"
Drying	Little resistance	Rhodes 1950
DRIED, LYOPHILIZED		
N. intracellularis		
Dried in frozen state	18 yrs	Elser 1935
Frozen and dried 16 hr. cult. on 10% rabbit blood pneumococcus agar plate in vacuo	151 d.	Rake 1935
Above with two wk. old stock strains	> 89 d.	"
Above with four fresh strains	>151, [illegible], >89, >41 d	"
2cc broth	>2 mos.	Swift 1921
N. gonorrhea		
Dried in frozen state	18 yrs.	Elser 1935
LIQUID		
N. intracellularis		
Bouillon, diffuse light, dried, ascitic agar, 37C.	24 h. (Raul str.)	Beltencourt 1904
Bouillon, 20-25 C., 80% RH	3 h.	"
Bouillon susp. of 24 h. with ascitic agar, 50 C.	3 min.	"
" " 55 C.	1 min.	"
" " 60, 70, 80 C.	30 sec.	"
" " 100 C.	30 sec.	"
Bouillon culture, 0-70 C.	1 mo. or longer	"
Ringers, 20 C.	8-10 d.	
Saline, 50 C.	poor	Flexner 1907
" 20 C.	fair	"
" 37 C.	good	"
Physiol. saline, R.T., abs. drying in vacuo	Viable for months.	Otten 1930
Pure, undil. neutral glycerine, -15 C.	No change in viability 2 yrs.	Pabst 1935
Saline broth, dried at R.T. or from frozen state	42%	Proom 1949
Broth, R.T.	.69%	"
Saline, -78 C.	36.2%	"
Sterile serum sealed with paraffin layer	16 mos.	Ungerman 1918

TABLE C 13 THE SURVIVAL OF NEISSERIA SPECIES IN CULTURE

Factor(s)	Survival	Reference
LIQUID		
N. intracellularis		
Culture, 104th generation	3-4 yrs.	Von Albrecht 1901
LIQUID		
N. gonorrheae		
Pigeon blood, pH 6.6	No growth, 12 d	Lal 1925
" " " 6.8	108 d.	"
" " " 7.0	108 d.	"
" " " 7.2	123 d.	"
" " " 7.4	159 d.	"
" " " 7.6	189 d.	"
" " " 7.8	189 d.	"
" " " 8.0	76 d.	"
Lactic acid plates in ice box 4-7 C., Pre-incub. in moist chamber.	Viable 9-15 d.	Lorentz 1924
Physiol. saline, R.T., abs. drying in vacuo	Viable for mos.	Otten 1930
Gentian violet, 20-26 C.	24 h.	Pelzer 1949
Physiol. NaCl, R.T., on ascitic agar, 24 h. cult.	Recov. 79.2%, 6 h.	Pieper 1930
Ringers soln., R.T. on ascitic agar, 24 h. cult.		
18 C.	Recov. 71.8% in 6 h.	"
" " " 22 C.	Recov. 30.7 % in 24 H.	"
Physiol. NaCl, 48 h. cult. on ascitic Levinthal med.		
18 C.	Recov. 57.9% in 6 h.	"
" " " 22 C.	Recov. 21% in 24 h.	"
Ringers soln. 48 h. cult on ascitic Levinthal med.		
18 C.	Recov 70.9%, 6 h.	"
" " " 22C.	Recov. 16% 24 h.	"
Saline broth, dried at R.T.,	1.5%	Proom 1949
Saline broth dried from frozen state	15%	"
Broth, R.T., saline, -78C.	0.93%	"
Sterile serum sealed with paraffin layer	7-8 wks.	"
SOLID		
N. intracellularis		
Serum agar, 37 C.,	8 wks	Dharmendra 1940
Pigeon blood agar, 37 C.	10 wks.	"
Serum agar 3.5-8.5 C.	27 wks.	"
Pigeon blood agar, 3.5-8.5 %	31 wks.	"
Yeast agar, 37 C.	>5 mos.	Eberson 1920
Agar surface, 2 C.	Poor	Flexner 1907
" " 32-37 C.	Good	"

TABLE C 13 THE SURVIVAL OF NEISSERIA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
SOLID, CONT.			
N. intracellularis			
Glucose agar slant, -15 C.	No loss of viab. 8 mos.	Pabst	1935
Gelatin 37 C., 1% acid added to phenolphthalein	>7 mos.	Worth	1919
N. gonorrheae			
Gelatin 37 C., 1% acid added to phenolphthalein	>8 mos.	"	
GENERAL			
N. intracellularis			
Various nutritive substances alter the survival period		Foa	1887
37 C.	> 86 d.	Lal	1921
Survival shortened at 37 C. and prolonged in ice box, 6-10 C.		Miller	1944
-	4 d.	Murray	1929
-5 C.	5 d	Pabst	1935
Icebox, 0-5 C.	48 h.	Von Albrecht	
" 65 C.	½ h.	"	1901
" 80 C.	Few min.	"	
" 100 C.	Immediate	"	
Stoppered with gutta percha, 19-21 C.	4-5 d.	"	
Dried and stoppered with gutta percha, incub. temp.	185 d.	"	
N. gonorrheae			
40 C.	99.7% 10 hrs.	Carpenter	1933
41 C.	99% 4-5 hrs.	"	
41 C.	100% 11-23 hrs.	"	
41.5 C.	7-20 hrs.	"	
42 C.	5-15 hrs.	"	
50 C.	Few min.	"	
Gentian violet, ice box	Stored 8 wks.	Peizer	1949
-20 C.	10 d.	Luniere	1914
-195 C.	24 h	"	

TABLE C/4 THE SURVIVAL OF PASTEURELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Pasteurella pestis			
37 C.	Most dead in 3 d.	Gladin	1898
Bubo juice, R.T., exposed to sun, dried.	3-4 h.	Kitasato	1894
Bubo juice, R.T., dried on coverslip	< 4 d.	"	
Dried	Viable 2 h	Tinker	1930
P. tularensis			
Susp. in mixt. of beef infusion, cystine & rabbit blood, dried, sealed	4 yrs.	Miller	1946
P. species			
Dried	4-5 yrs.	Proom	1949
LIQUID			
P. multocida			
Broth culture, R.T., in sealed ampule	(Avicida) 2 yrs	Nobrega	1950
Broth culture, 2-4 C. in sealed amp.	" 1 yr.	"	
Broth culture, 37 C.	" 1 yr.	"	
Serum, 37 C.	" 4.5 h.	Panisset	1925
P. pestis			
Pus on cover slip, 28-30 C., innoc. to bouillon	4 d.	Abel	1897
Pus and cult. on cover glass, R.T.	Still viable 6-9 d.	"	
Pure undil. glycerine, -150 C.	Fully virulent 2 yrs & 14 mos. Slightly, 2 yr. & 7 mos. Dead 3 yrs.	Francis	1932
Physiol. serum	5 hrs.	Jacotot	1926
Bouillon cult., -31 C.	5½ mos.	Kasansky	1899
" " -24 C.	Still viable for 9, 32, & 35 d. respectively for 1st & 2nd subcult. 33d for 3rd subcult.		
" " -1.8 C.	6th to 15th subculture, 12 mos.	"	
Bouillon cult., 1 yr & 9 mos. old	Recov. 58.6%, 6½ yrs.	Lenskaja	1931
Bouillon, 48 & 24 hr. cult.	7 d.	"	
Sealed culture tube of Hammorek medium, 100 C. dark.	Living >4 yrs.	Schultz	1901
Bouillon loops, 50 C.	Innoc. with original culture which is 2 yrs. and 10 mos. old. 1 to several days.	"	
Twiks soln	2 h	Tinker	1930

TABLE C 14 THE SURVIVAL OF PASTEURELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference
SOLID		
P. pestis		
Gelatine, 15 C.	3-4 d.	Abel 1897
" 8-10 C.	6 d.	"
Agar and gelatine Cult.	-	"
Plain agar 10 C. sealed for 9 yrs.	Viable at end of 9 yrs. with full virulence	Francis 1932
Plain agar 10 C. Subcultured every 3 mos.	Viable but non-virulent at end of 9 yrs.	"
Culture 5-10 C., Innoc. into cork stoppered bottle.	25 yrs.	Francis 1949
Beef infusion agar, 10 C on surface without transfer	Virulent 20 yrs.	Francis 1943
Agar cult. in sun, 39 C.	2 3/4 hrs.	Gladin 1898
Agar plate in sun, 40-46 C.	5½ hrs.	"
Agar cult., -1.8 C.	1st subcult. still viable 4 mos.	Kasansky 1899
" - 31 C.	2nd and 3rd subcult. 5-5½ hrs.	"
GENERAL		
P. pestis		
Artificial cold, -22 C.	2 h.	Gabritschewsky 1899
Natural cold, 0 to -20 C	12-40 d.	"
Freeze and [illegible]ally, -20 C.	Still alive 40 d.	Gladin 1898
Stored 37 C.	1% survived 4 yrs.	Stamp 1947
Ice box culture	10yrs, 5 mos.	Wilson 1913
P. pleurisepticus		
Physiol. NaCl, R.T., abs dried over H_2SO_4 in vacuo.	Viable for months.	Otten 1930
P. pseudotuberculosis		
Sealed and viable.	Viable for a number of yrs.	Merling 1938
P. species		
Physiol. NaCl, R.T., Abs dried over H_2SO_4 in vacuo.	Innoc. into blood or serum, viable mos.	Otten 1930
P. tularensis		
Eggs, freezing	Recov. 1%, 3 mos.	Downs, 1947
Factors leading to population changes. 1) Type & comp. of med., 2) initial pH, 3) Inoculum size, 4) One or more factors present in old cult. filtrates		Eigelbach 1951

TABLE C 15 THE SURVIVAL OF PROTOZOA AND METAZOA IN CULTURE

Factor(s)	Survival	Reference
LIQUID		
E. histolytica		
Ringers' fluid & solid rice starch, body temp.	3 wks.	Dobell 1926
Dist. H_2O, tap water, Ringers, physiol. saline, R.T.	14 d.	"
10-20 C., R.T.	3 d.	"
Sterile dist. water, R.T.	26 d.	Dobell 1927
N/20 HCl, R.T.	<30 min	"
N/40 HCl; R.T.	at least 1 h.	"
N/15 HCl; R.T.	as long as 3 h.	"
N/20 HCl, 37 C.	1 h.	"
Plasmodium gallinaceum		
Susp. saline extract, R.T. in washed chicken rbc.	Little loss of infectivity 72 hrs.	Whitman 1948
Trypanosoma cruzi		
N.N. medium, R.T.	>6 yr.	Packchanian 1943
Trichomona vaginalis		
R.T.	8 d.	Mohr 1937
Bact. free in serum, Ringers soln. over liver infusion agar slants, 37 C.	4-6 d.	Trussell 1947
Cysteine, peptone broth, liver, maltose, R.T.	13 d.	"
SOLID		
S. mansoni		
Horse serum	14-18 d.	Ross 1950
Serum ultra filtrate	10-12 d.	"
100% N_2	5 d.	"
L. donovani		
Blood agar, R.T.	4 mos.	Packchanian 1943
T. americanum		
Blood agar, R.T.	4 mos.	"
T. avium		
Blood agar, R.T.	3 mos.	"
T. duttoni		
Blood agar, R.T.	4 mos.	"
T. lewisii		
Blood agar, R.T.	4 mos.	"
T. malophagium		
Blood agar, R.T.	4 mos.	"
T. rotatorium		
Blood agar, R.T.	4 mos.	"
T. vaginalis		
Semi-dry state	6 hrs.	Vazques-Calet 1936
GENERAL		
E. histolytica		
Powdered starch, R.T.	10 d.	Walker 1913

TABLE C 15 THE SURVIVAL OF PROTOZOA AND METAZOA IN CULTURE

Factor (s)	Survival	Reference	
GENERAL, CONT.			
T. vaginalis			
3-5 C.	21 d.	Fischer	1935
10-15 C.	2-3 wks.	Florent	1948
Lactic acid .27 to .102 mg%, ice box	3 d.	Furushima	1936
Trypanosoma equiperdium			
-20 C.	3 1/4 hrs.	De Jong	1922
-145 C.	45 min.	"	
-191 C.	31 d.	"	
Trypanosoma evansi			
-20 C.	$1\frac{1}{4}$ hrs.	"	
-191 C.	9 min.	"	
Ascaris lumbricoided			
-6 to -17 F.	Inactive 20 d.	Cram	1924
12-18 F.	Active 30 d.	"	
10-18 F.	Few active 6 d.	"	
-2 to -16 F.	Few active 6 d.	"	
-6 to -17 F.	40 d.	"	
60 C.	5 min.	Ohba	1923
70 C.	10 sec.	"	

TABLE C/6 THE SURVIVAL OF RICKETTSSIAE IN CULTURE

Factor(s)	Survival	Reference	
DRYING, LYOPHILIZED			
R. tsutsugamushi			
Soln. 0.2 M. sucrose plus buffer salts	Superior to skim milk medium	Jackson	1951
LIQUID			
Coxiella burneti (Dyer, nine mile and Henzerling str.)			
Saline susp. yolk sac. 60 C.	30 min.	Ransom	1951
" " 50 C.	15 min.	"	
R. mooseri, & prowazeki			
Yolk sac material, -72C., .005 glutamate, pH close to 7, basal salt soln., high in K ions, .1 to 1% serum albumin.	Survival favored by these.	Bovarnick	1950
Tissue cult., in serum with Tyrodes, 37 & -20C	Several mos.	Nigg	1935
" " 20 & -40C	Week or two	"	
R. prowazeki			
Sterile skim milk, 26-28 C.	24 h.	Anderson	1944
Broth, 26-28 C.	6 h. (Breine str.)	"	
20% normal yolk sac, 26-28 C.	50% mortality, 6 hrs. (Bogota epidemic Str.)	"	
Tyrodes soln. 26-28 C	6h.	".	
Tyrodes, G.P. serum, 26-28 C.	6 h.	"	
56 C.	30 min	Rivers	1948
Blood spec 2-4 C.	1 or more h.	"	
" " 37 C	few hrs.	"	
Dessicated, R.T.	Few hrs.	"	
G.P blood, R.T.	few hrs.	"	
Carbon tet. or benzene, CS_2, 25% NH_3, ether, cresol, ethylene Cl_2,	Viable >1 h.	Schlote	1948
tetramine	<7 min.		
Physiol. saline with tap water	Affects viability deleteriously.	Topping,	1940
R. species			
Aqueous susp.	40 hrs.	Latarjet	1951
Chick embryo dil. 1/10 N. saline, 50 C.	1 wk.	Payzin	1947
Chick embryo dil. with Tyrodes & horse serum.	Not viable after 20 d.	"	
Chick memb., -14 C., with carbon snow in presence of P_2O_5, sealed under H_2	13 d.	"	
R. rickettsi			
Pure glycerol, -10 C.	10 mos.	Spencer	1924
Rocky Mtn. Spotted Fever			
Dessicated, R.T.	few hrs.	Rivers	1948
Guinea pig blood, R.T.	1 wk.	"	

TABLE 6/6 THE SURVIVAL OF RICKETTSIAE IN CULTURE

Factor(s)	Survival	Reference
LIQUID		
Rocky Mtn. Spotted Fever		
G.P. blood, cold room	2 wks.	Rivers 1948
G. P. blood, brain & spleen, -7 C.	1 yr.	"
Typhus		
Broth, pH 7.69	Trace 48 hrs.	Elford 1944
Fermented broth, pH 8.10	Trace 96 h.	"
Saline, pH 6.85	Trace 48 h.	"
Serum & saline, pH 7.93	" 48 h.	"
Water, pH 6.95	" 2 h.	"
Peptone water, pH 7.06	" 2 h.	"
Tyrodes soln., pH 8.18	" 2 h.	"
GENERAL		
R. burneti		
-70 C.	Long time	Rivers 1948
Infection spread by means of air borne droplets.		Commen. on Resp. Dis. 1946
R. prowazeki		
Dry heat, 39 C.-41 C.	1 h	Schlote 1948
Scrub typhus		
-70 C.	long time	Rivers 1948
Typhus		
77 C., pH 5.8-8.8	4 mos.	Elford 1944
-10 or 0 C.	2-3 days.	"
37 C.	Trace 48 h.	"
23 C.	" 2 h.	"
0 C.	" 48 h.	"
-10 C.	Present 8 d.	"
-77 C.	" 8 d.	"

TABLE C/7 THE SURVIVAL OF SALMONELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference
DRIED, GENERAL		
S. Paratyphi		
Dried.	Viable > 2 h.	Orskov 1925
Nutrient gel with ascorbic acid. Dessic. 3 d.	Recov. 55.7% 23 d.	Stamp 1947
Nutrient gelatin & ascorbic acid. Dried over P_2O_5 at 100-300 mm Hg. Stored in vacuo, R.T.	>4 yr. survival	"
S. Species		
Dried	4-5 yrs.	"
DRIED, LYOPHILIZED		
S. choleraesuis		
Broth culture	10 yrs.	Schoening 1949
LIQUID		
S. choleraesieus		
Glucose-peptone water	7 d.	Oshii 1920
S. enteriditis		
NaCl soln.	4½ wks.	Karaffa-Korbutt 1912
S. hiss	1,283 d.	Lal 1925
Glucose peptone water	5-7 d.	Oshii 1920
NaCl soln.	Recov. 0, 4½ wks.	Stadler 1899
S. morbificans		
NaCl soln.	3 wks.	Karaffa-Korbutt 1912
NaCl soln.	Recov. 0, 3 wks.	Stadler 1899
S. paratyphi A		
Tryptic digest	3,259 d.	Lal 1925
Bouillon, 63 C.	Viable 1-4 min.	Orskov 1925
Saline, 0.9%, 62 C.	< 5 min.	"
Lactose peptone water	3-5 d.	Oshii 1920
NaCl soln, R.T., dried in vacuo	Viable mos.	Otten 1930
S. paratyphi B.		
Muttan, agar	3.259 d.	Lal 1925
Bouillon 63 C.	4 min	Orskov 1925
Lactose-peptone water	3-6 d.	Oshii 1920
NaCl soln. R.T., dried in vacuo	Viable mos.	Otten 1930
S. schottmulleri		
Broth & water, frozen	17 d.	Thomas 1925
S. species		
Bouillon cult., in glass capillaries	>1 yr.	Wesselinoff 1949
S. typhimurium		
Bouillon & beer wort, exposed to U.V. 10-15 min.	1-15 sec.	Gilles 1935
SOLID		
S. enteriditis		
transmitted by rat fleas		Eskey 1949

TABLE C/2 THE SURVIVAL OF SALMONELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
SOLID			
S. enteriditis			
Blood gelatin	> 649 d.	Lal	1921
S. Paratyphi B.			
Crust of rye bread, R.T.	-	Bachmann	1943
S. typhimurium			
Gelatin	98 d.	Glass	1946
GENERAL			
S. choleraesuis			
-	> 657 d.	Lal	1921
-	1,562 d.	Lal	1925
S. gallinarum			
Stored at 37 C.	28.4% surv. 4 yrs.	Stamp	1947
S. Paratyphi C			
-	50 d.	Kister	1928
Stored at 37 C.	14% surv. 4 yrs.	Stamp	1947
S. typhimurium			
Stored at 37 C.	18.4% survived 4 yrs.	Stamp	1947
S. typhisuis			
Stored at 37 C.	16.2% " "	"	

TABLE C/8 THE SURVIVAL OF SALMONELLA TYPHOSA IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Dried in thin layers	5-15 d.	Osler	1901
" " thick layers	mos.	"	
Vacuum dried, -195 C.	4 d.	Shattock	1912
Air dried, dark	4 d.	"	
DRIED, LYOPHILIZED			
Standardized susp., -192 C.	10 d.	Turner	-
LIQUID			
.85% NaCl, freezing	> 6 d.	Bolten	1918
Bouillon culture, continuous freezing @ -20 to -16C	Survived 4½ mos.	Brehme	1901
Watery susp. of fresh cult. placed on petri dish in sunlight.	Innoc. 100. 95-99% reduct. in 10-15 min. 100% reduct. ½-4 hrs.	Clark	1903
1% soap soln, 4-8 C.	12 h.	Jolles	1895
6% " " "	15 min.	"	
1% " " 18 C.	24 h.	"	
6% " " "	30 min.	"	
5% " " "	1 h.	"	
3% " " "	12 h.	"	
Bouillon susp., R.T., Fall on Petri dishes	24 h.	Kirstein	1902
Tryptic digest	3,838 d.	Lal	1925
-185 C., liquid air	No impaired vitality 20 h.	MacFayden	1899
Broth emulsion with liquid air.	No impaired vitality, 7 d.	MacFayden	1900
Sealed tubes, liquid air.	6 mos.	"	
Liquid H_2, -252 C.	10 h.	"	
Beef-peptone agar in sun	10 min. to 1 h.	Minck	1896
Bouillon, 63 C.	Viable 1-2 min	Orskov	1925
Lactose peptone water	3-5 d.	Oshii	1920
Thick susp., R.T., dried in vacuo over H_2SO_4	Innoc. to blood or serum agar, 2-5% survived 24-48 h.	Otten	1930
NaCl soln., R.T., dried in vacuo	Innoc. to blood or serum agar. Viable mos.	Otten	1930
Bouillon, neutral pH	82 d.	Remy	1900
Peptonized beef bouillon freezing, -17.8 C.	Recov. 1/45, 2 h.	Smith	1905
" -190 C. in liquid air.	Recov. 2/60, 2 h.	"	
Peptonized beef bouillon, frozen	99.5% killed 2 h.	"	
-17.8 C.	.5% recov. 2 h.	"	
Huntoon broth, frozen	13 d.	Thomas	1925
Susp. in agglut. immune serum	No effect on surv. time	Tinti	1923
Emulsion 24 hr. bouillon cult. in salt soln. heated at 80 c. for 10 min.	2-8 hrs. (6X as much needed to kill spores.	Weinzirl	1914
Liquid air in glass	Recov 25% 2 h.	White	1901

TABLE ___ THE SURVIVAL OF SALMONELLA TYPHOSA IN CULTURE

Factor(s)	Survival	Reference	
SOLID			
Crust of rye bread, R.T.	4½ mos.	Buchanan	1943
Agar, full radiation Hg arc under glass, water cooled.	10 min at 10 cm.	Bazzoni	1914
Agar & gelatin plates	1½ h (July, March, Aug.)	Dieudonne	1894
" " "	2½ h (Nov)	"	
" " "	4½ h (Winter)	"	
Salt media	91 D.	Frank	1941
Nutrient gel tubes, 22 C.	No change in 8 d.	Ransome	1901
Action of H ions on micro-org. is very rapid & is increased by raise in temp. By changing the temp. from 20 to 45 C. the pH at which typhoid bacilli are killed shifts from 4.2 to 5.1.		Sierakowski	1924
Gelatin, 20 C., 1% acid added to phenolphthalein	> 8 mos.	Worth	1919
GENERAL			
Artificial media	> 5 wks.	Houston	1912
-	> 929 d.	Lal	1921
113 C.	Living	Lal	1923
120 C.	Dead	"	
R.T., Dark	2,906 d.	"	
60 C.	10 min.	Osler	1901
-50 C.	18 wks.	"	
-2 to -7 C.	22wks.	Park	1924
45 C.	Dried after 46th change	Spencer	1942
Storage at R.T.	50% surv. 4 yrs.	Stamp	1947
" "	5.6 " "	"	
" "	18.8% " "	"	
" "	1.3% " "	"	
" "	16.7 " "	"	
Sunlight has no appreciable inhibiting effect		Stimson	-
Ice cream, -19 C.	1 yr.	Tanner	1928
Excess lime, pH 9-9.5	> 540 min.	Wattie	1943
" " " 9.5-10	> 540 min.	"	
" " " 10-10.5	> 540 min.	"	
" " " 10-5-11	240 min.	"	
" " " 11-11.5	120 min.	"	

TABLE C/9 THE SURVIVAL OF SERRATIA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
S. spp.			
Dried	4-5 yrs.	Proom	1949
DRIED, LYOPHILIZED			
S. marcescens			
Stored at R.T., dark.	Survivals 100%. Viability lost when stored in air.	Naylor	1946
S. rubidaeum			
Frozen at -24 C.	82.2% killed in 1st freezing	Stille	1943
LIQUID			
S. marcescens			
Standard nutrient broth, R.T.	29-21 yrs.	Deacon	1932
Bouillon susp., R.T.	24 h.	Kirstein	1902
Broth, -13 to -15 C.	Recov. .1%, 8-9 wks.	Tanner	1928
Salt soln. " "	" .1%, 12-16 wks.	"	
Broth, before centrifug.	100% survival	Winslow	1927
" after "	44% "	"	
" 1 hr. later	37% "	"	
SOLID			
S. marcescens			
Agar & gelatin plates, March, July, Aug.	1½ h.	Dieudonne	1894
GENERAL			
-10 to 1 C. (S. marcescens)	51 d.	Hilliard	1918
S. marcescens			
-	658 d.	Lal	1921
Stored at 37 C.	16% recov., 4 yrs.	Stamp	1947

TABLE C 20 THE SURVIVAL OF SHIGELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED GENERAL			
S. spp.			
Dried	4-5 yrs.	Proom	1949
Dessicated	20-25 d.	Vaillard	1903
LIQUID			
S. dysenteriae			
Bouillon	920 d.	Lal	1921
Mutton, agar slope	1,562 d.	Lal	1925
Thick susp., dried in vacuo over H_2SO_4, R.T.	Innoc. to blood or serum agar. Recov. .05-.005% 24-48 h.	Otten	1930
NaCl soln. R.T., dried in vacuo	Innoc. blood or serum agar. Viable mos.	"	
Saline, -78 C., freeze in CO_2.	25%	Proom	1949
Broth, -78 C.	96.5%	"	
Broth, R.T.	32.2%	"	
Saline, -78 C.	42.3%	"	
S. paradysenteriae (Flexner)			
Bouillon	>1,044	Lal	1921
Mutton, agar slope	1,562 d.	Lal	1925
S. paradysenteriae (His Y)			
Mutton, agar slope	1,562 d.	Lal	1925
S. pseudodysentery			
Physiol saline, R.T.	-	Otten	1930
S. spp.			
Alcohol, ether, chloroform, 37 C.	few hrs.	Vaillard	1903
SOLID			
S. dysenteriae			
Crust of rye bread, R.T. placed on Drigalski med.	Viable 20 d.	Bachmann	1943
Crust of rye bread, R.T.	66 d.	"	
Solid substance (Y type)	5 d.	Tashiro	1932
S. Paradysenteriae (Flexner)			
Crust of rye bread, R.T. placed on Drigalski med.	Viable 23 d.	Bachmann	1943
Crust of rye bread, -5 to -25 C.	Viable 45 d.	"	
S. sonnei			
Crust of rye bread, R.T.	Overgrown with spores of bacillus	"	
GENERAL			
S. dysenteriae			
48 hr. cult., 37 C.	13 d.	Bamberger	1936
" " 22 C.	15 d.	"	
" " 10 C.	24 d.	"	
72 h. cult. 37 C.	13 d.	"	
" " 22 C.	16 d.	"	
" " 10 C.	24 d.	"	
Bouillon, strong sun	<30 min	"	

TABLE C 2d THE SURVIVAL OF SHIGELLA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL, CONT.			
S. dysenteriae			
-	10 d.	Kister	1928
Dark, R.T.	920 d.	Lal	1925
Stored 37 C.	4.5% survived 4 yrs.	Stamp	1947
Excess lime pH 9.5-10	>300 min	Wattie	1943
" " pH 10-10.5	>300 min.	"	
" " " 10.5-11	180 min.	"	
" " " 11-11.5	75 min.	"	
S. equuli			
Cult., R.T., pH 7.4, Stored in dark.	3-4 mos.	McCollum	1951
S. ambigua(Schmitz)			
Cult. in bouillon, strong sunlight	< 40 min.	Bamberger	1936
S. kruse			
48 h. cult., 37 C.	12 d.	Bamberger	1936
" " 22 C.	15 d.	"	
" " 12 C.	24 D.	"	
72 h. cult., 37 C.	13 d.	"	
" " 22 C.	15 d.	"	
" " 12 C.	24 d.	"	
Bouillon, strong sun	<30 min.	"	
S. paradysenteriae(Flexner)			
Bouillon, strong sun.	<60 min.	"	
R.T., dark	1,049 d.	Lal	1925

TABLE C 2 / THE SURVIVAL OF STAPHYLOCOCCUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL			
S. albus			
Stock lab cult., sealed, R.T.	11-12 yrs.	Ahuja	1935
-	523 d.	Lal	1921
Material obtained from sputum, antrum, nose, skin, throat, urine, uterus & put in broth & adjusted with HCl and NaOH. Of 12 strains used 7 viable at pH 2.6; 4 at pH 5.0; 1 at pH 8; 8 at pH 10 for 24 h.		Hall	1921
S. aureus			
-	524 d. (Bombay str.)	Lal	1921
"	> 692 d.	"	
Dark, R.T.	657 d.	Lal	1925
Matl. obtained from boil, abscess, sycosis, spinal fluid, in broth.	11 strs. viable at pH 2.6; 6 at pH 8; 13 at pH 10 in 24 h.	Hall	1921
S. citreus			
-	523 d.	Lal	1921
S. spp.			
Dessication	30 yrs.	Fasquelle	1950
60-100 C., in broth & dist. water, dried on collodion	cell membrane separated	Ruska	1941
Very resistant to drying		Rhodes	1950
MICROCOCCUS SPECIES			
GENERAL			
M. melitensis			
-	523 d.	Lal	1921
M. neoformans			
"	523 d.	"	
M. pyogenes			
Sensitive to .85% NaCl		Zeug	1920
SOLID			
M. aurococcus			
Agar covered with sterile 10% cane sugar soln. & holding at 10 C.	8 mos.	Keith	1913
M. candicans			
Nutrient gel, 22 C.	No change, 8 d.	Ransome	1901
M. catarrhalis			
20 C.	3 mos.	Worth	1919

TABLE C 2 / THE SURVIVAL OF STAPHYLOCOCCUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
S. aureus			
Dry ice & ether	wks.	Paul	1907
Liquid air	125 d.	"	
Dried on small stones in vacuo at low temp.	Recov. 40%	"	
Vacuum dried, 195 C	16-22 d.	Shattock	1912
Air dried	16-22 d.	"	
S. spp.			
Dried on garnets, R.T.,	Innoc. 90,000, Recov. 300, 32 d.	Paul	1909
" " ice box	Innoc. 88,800, Recov. 550, 32 d.	"	
" " temp. of Liquid air	Innoc. 65,990, Recov, 67,900, 32 d.	"	
Dried	4-5 yrs.	Proom	1949
LIQUID			
S. albus			
.85% NaCl, -252 C.	50 h.	Kadisch	1931
S. aureus			
Saline susp., 6-11 C., R.H. 70-85%, CO_2 5-4%	70% destruct., >8 d.	Arai	1931
High pressure, R.T., 3000 atmospheres.	45 min.	Basset	1932
Broth	15 d.	Bellelli	1928
Pus culture, R.T., sealed glass tubes	2½-3½ yrs.	Belin	1933
Dextrose, bouillon cult., freezing, 48 h., vacuum dessicated.	54 d.	Hammer	1911
Bouillon susp., R.T., in cellar, fine drops	35 d.	Kirstein	1902
Pure culture	28 d.	"	
Liquid air, -185 C.	No impaired vitality 20 h.	MacFayden	1899
Liquid air	6 mos.	"	1900
Liquid H_2, -252 C.	10 h.	"	
Physiol. NaCl soln, R.T. Dried in vacuo over H_2SO_4.	Viable for mos.	Otten	1930
Serum, 37 C.	Up to 11 d.	Panisset	1925
Met. violet	Recov. 0, 1 min.	Philibert	1926
Saline, -78 C., Freeze in CO_2 ice.	100%	Proom	1949
Broth, freeze in CO_2.	100%	"	
37 C.	Viable 2 yrs.	Rhodes	1950
SOLID			
S. spp.			
Nutrient agar, below 10C.	No growth	Haines	1934

TABLE 622 THE SURVIVAL OF STREPTOCOCCUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
S. species			
Dried	7 yrs.	Lal	1948
Dried	4-5 yrs.	Iroom	1949
Dried	2/3 of original, 97 d.	Stark	1931
DRIED, LYOPHILIZED			
S. hemolyticus			
Dried 12 h.	51 mos.	Swift	1921
Frozen and dried	many yrs.	Swift	1937
LIQUID			
S. hemolyticus			
Citrate, gelatin, R.T.,	>3 d.	Meleney	1924
Lockes gelatin, 37 C.	>12 h.	"	
Bacteria indifferent to osmotic pressure. Bivalent & univalent salts antagonize each other at certain levels.		"	
Susp. in broth or saliva in dry air.	Highly suscept. to triethylene glycol vapor after 5 h. dessicat.	Robertson	1951
" " " low R.H.	Slower rate of killing	"	
Veal infusion broth, 22C	at least 60 d. (alpha)	Surgalla	[illegible]
" " " 37 C	At least 30 d. "	"	
S. spp.			
Egg white, 50 c.	4 h.	Belin	1933
Peptone 1/20	3 h.	"	
Alanine 1/20	5 h.	"	
Glycochol 1/100	13.5 h.	"	
leucine 1/100	13.5 h.	"	
Physiol NaCl, R.T., absolute drying in vacuo.	Viable months	Otten	1930
Sprayed culture	All organisms settled in 48 hrs.	Phelps	1939
Sensitized with methyl violet	Recov. 0, 30 min.	Philibert	1926
Brain tissue, glycerol 50%	>303 d	Rhoads	1929
S. salivarius			
Serum broth, 17 C., RH 77% Ozone .6-.4PPM	>99% killed	Elford	1942
GENERAL			
S. agalactiae	mos.	Watts	1941
RH 0	3 yrs.		
RH 75%	8 wks.	"	1945
RH 55%	26 wks.	"	
RH 25 %	156 wks.	"	
RH 10%	156 wks.	"	
S. aureus			
Stored at 37 C.	-	Stamp	1947
S. fecalis			
Stock lab. cult., sealed test tube, R.T.	11-12 yrs.	Ahuja	1935
S. hemolyticus			
Capillary tubes, -17 to -18C.	2 wks.	Citovicz	1928

TABLE C22 THE SURVIVAL OF STREPTOCOCCUS SPECIES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL, CONT.			
S. hemolyticus			
42 C.	Can stand numerous transfers	Spencer	1942
S. lactis			
Young cells, 1 C.	Inoc. 28,000,000, Recov. 620,000, 62 d.	Sherman	1942
Mature cells, 1 C.	Inoc. 350,000,000, Recov. <1, 51 d.	"	
S. spp.			
RH 70-90%	rapidly killed	Elford	1945
Death rate of S. spp. decreased in certain carbohydrates when dessicated. Using progressively dust, water, xylose, saline, tryptophane, salicin, glucose & sucrose the % death rate decreased from 66.8 to 5.0 dessicated compared with 81.6 to 88.0 for the same fluid controls.		Heller	1941
Varies in resistance to methylene blue		Louros	1923
60-100 C., 4-24 h. broth or agar cult.	Plasmolysis	Ruska	1941

TABLE C 23 THE SURVIVAL OF TREPONEMA SPECIES IN CULTURE

Factor(s)	Survival	Reference
DRIED, GENERAL		
T. pallidum		
40 C.	2 hrs.	Besseman 1930
42 C.	1 hr.	"
Dried	1-2 d.	Landsteiner 1906
Dried in vacuo, R.T.	No movement, 4 d.	Zurhelle 1927
Under paraffin, liquid, R.T.	Movements 3 d, 17 hr.	"
Under paraffin, ice box	Movements 5-7 d.	"
Dried in vacuo, R.T.	No movement 68 h.-4 d.	"
Dried in Petri dish, R.T.	Still viable 65 hrs.	"
DRIED, LYOPHILIZED		
T. pallidum		
7 mo. cult., dried from frozen state. Stored 8 C.	168 hrs.	Hampp 1947
Rabbit testes in infusion broth, -78 C.	3 yrs.	Turner 1939
-10 C.	< 2 mos.	Turner 1938
-20 C.	< 2 mos.	"
-78 C.	1 yr.	"
-78 C.	1 yr.	"
T. pertenue		
Rabbit testes in infusion broth, -78 C.	3 yrs.	Turner 1939
-78 C.	1 yr.	"
LIQUID		
T. hispanicum		
Blood of G.P., 14-20 C.	29 samples; 25 virulent 2-33 d.	Sergent 1938
" " 0 C.	6 samples; 0 virulent 33-60 d.	"
" " 0 C.	20 samples; 18 virulent 2d-7wks.	"
" " 10 C.	1 d.	"
Chorioallantoic memb. of 150 h. chick embryos.	< 4 h.	Sterzi 1939
T. pallidum		
Saline susp. 45 C.	Killed 7-10 min.	Bronfenbrenner 1913
10% rabbit serum, -10 C.	> 15 d.	Hindle 1934
½ inactive dog serum, ½ physiol salt soln., 20.4-3.65 abs.	4 h.	Jahnel 1938
Above at 1.7 abs.	2½ h.	"
Serum exudate from chancre R. T.	121 d.	Lacy 1921
Saline susp. rabbit testes, R.T.	58 d.	"
Brewers fluid, thioglycollate below 37 C. incub. with rabbit testes	Improved survival	Nelson 1948
Expos. to 5% CO_2 with isotonic PO_4 buffer, pH 7.0	Prolonged survival	"

TABLE C 23 THE SURVIVAL OF TREPONEMA SPECIES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, CONT.			
T. pallidum			
Isopropylidene with TPS factor, 147-148 C.	Prolonged survival	Rice	1951
Rabbit plasma, 5 C.	6 d.	Selbie	1943
Chorioallantoic memb. of 150 h. chick embryos	< 4 h.	Sterzi	1939
Physiol NaCl & human serum under vaseline, R.T.	Motionless, 5 d.	Zurhelle	1927
SOLID			
T. spp.			
Deep tubes of agar anaerobically under paraffin oil at R.T. and 37 C. in dark was not satisfactory.		Rosebury	1950
GENERAL			
T. pallidum			
Culture, 39 C.	5 h.	Boak	1933
" 40 C.	3 h.	"	
" 41 C.	2 h.	"	
" 41.5 C.	1 h.	"	
-16 C.	3 mos.	Kissmeyer	1928
2 C.	Some days	"	
Cult. between 0 & 5 C.	>101 h.	Krantz	1923
10 C.	Lost power of producing lesion, 3 h.	Landsteiner	1906
Ice chest	24 h.	"	
48 C.	30 min.	"	
37 & 0 C.	4 h.	Miyao	1930
Syphilitic matl., 10 C.	3 h.	Neisser	1911
" " ice chest	24 h.	"	
" " 48 C.	30 min.	"	
Crystalline bovine alb., Na pyruvate, inorg. PO_4 buffer, glutathione, cysteine, vitamins & $NaHCO_3$, 30 C., under 5% CO_2-95% N_2	8-10 d.	Nelson	1948
Culture of rabbit testes	10 d.	Perry	1948
Stored in solid CO_2	5-20 mos.	Rosebury	1950
Chick embryos, 35 C.	>8 d.	Wile	1941
Aerobic, damp chambers, R.T.	4 d.	Zurhelle	1927
" " " 37 C.	48 h.	"	
" " " ice box.	Still viable 3 d., 17 h.	"	
T. pertenue			
60 C.	15 min.	Marchoux	1938
37 C.	2 h.	Miyao	1930
0 C.	<15 min.	"	
T. spp.			
Temp ranging from that of liquid O_2 to that of liquid He	Survived	Luyet	1938

TABLE C 24 THE SURVIVAL OF VIBRIO SPECIES IN CULTURE

Factor(s)	Survival	Reference
DRIED, GENERAL		
V. comma		
Peptone, water cult. dried in vacuo over P_2O_4. R.T. Sealed glass tubes.	4 yrs.	Campbell-Renton 1942
(Schillong 653)	Orig. count, 9 X 10^6. After 4 yrs., 240	"
(Rangoon R)	Orig. count, 6 X 10^6 After 4 yrs., 50	"
(Schillong 1077)	Orig. count, 9 X 10^6 After 4 yrs., 50	
(Schillong 610 R)	Orig. count, 125 X 10^7 After 4 yrs., 0	"
Dried	4-5 yrs.	Proom 1949
V. foetus		
Dried	3-4 yrs.	"
LIQUID		
V. comma		
Sterile sat. soln. NaCl in water	<1 d.	Arguelles 1927
Fish extract, sterile	125 d.	"
Bouillon cult. with Cont. freeze -10 to -16C.	57 d.	Brehme 1901
Bouillon, -8 to -18 C.	Perished in 5 d.	"
Peptone, water cult., R.T. Dried in vacuo, sealed tubes over P_2O_5	4 yrs.	Campbell-Renton 1942
0.3 g. NaCl & 10 cc agar 38 C. (El tor)	Normal & invol. forms.	Eisler 1909
38 C., .3 gm NaCl	Invol. & normal forms.	"
0.3 gm NaCl & 0.05 gm $Ca(NO_3)_2$	Normal forms.	"
0.3 gms NaCl & 0.1 g. $Ca(NO_3)_2$.	Invol. & Normal forms.	"
Meat infusion	4-5 wks.	Hesse 1889
Ham broth	4-5 wks.	"
Bouillon susp. R.T.,	10 h.	Kirstein 1902
Bouillon cult., 106 D. old.		
dried in air	2 d	Kitasato 1889
dried in exicator	3 d.	"
Bouillon cult., 15 d. old.		"
dried in air	3 d.	
dried in exicator	3 d.	"
Bouillon cult., 1 d. old.		
dried in air	30 h.	"
dried in exicator	40 h.	"
Bouillon cult., 40 h. old.		
dried in air	40 h.	"
dried in exicator	40 h.	"

TABLE 024 THE SURVIVAL OF VIBRIO SPECIES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID			
V. comma			
-	>894 d.	Lal	1921
- (Bombay str.)	>657 d.	"	
- (Lister str.)	>658 d.	"	
Liquid air, -185 C.	No impaired viability 20 h.	MacFayden	1899
Peptone broth, liquid air, -252 C.	No impaired vitality 10h.	"	1900
Broth emulsion with unster. milk, liquid air.	No " " 7 d.	"	
Liquid H_2, -252 C.	10 h.	"	
Thick susp. R.T., dried in vacuo over H_2SO_4	1 out of 100,000 survive 24-48 h. after innoc. into blood or serum.	Otten	1930
Physiol. NaCl, R.T., abs. drying in vacuo	Innoc. blood or agar dult., Viable mos.	"	
Saline	12%	Proom	1949
Broth	47%	"	
Broth, R.T.	5.5%	"	
Saline, -78 C.	4.7%	"	
1/5,000 peptone with salt	3 d.	Read	1939
Ster. salt, water, ice 0.5-7.0 C.	6-7 d.	Renk	1893
" " " "	Innoc 1,483,000/cc. Recov. 62,445/cc after 24 h.	"	
Beef bouillon in cotton stoppered test tube.	Viable & path. 5 wks.	Skidmore	1932
30% sat. NaCl	24 h.	Tohyama	1925
1 & 5% soln. 5th class table salt	4 d.	"	
Peptone water	11 d.	"	
Bouillon	26 d.	"	
NaCl 20 & 25%, -70 C.,	24 h.	Tohyama	1930
Peptone water, -60 C.	Innoc. 40,000/cc, Recov 0,1 mo.	"	
Bouillon, -60 C.	Innoc. 40,000/cc, Recov. 0, 40 d.	"	
1to 25% saline	Survived 3 d.	"	
20% NaCl, -70 C.	Innoc. 390,000/cc, Recov. 0, 24 h.	Tohyama	1930
Physiol. NaCl, -70 C.	48 h.	"	
Peptone water, pH 7.9	>108 d.	"	
Bouillon, pH 7.9	>108 d.	"	
Peptone, 5-6.5 C.	21 d.	Weiss	1894
Bouillon, 22-25 C., dark	16 d.	"	
SOLID			
V. comma			
10 cc. agar, 38 C., 0.46 gm. NaCl	Many invol. forms.	Eisler	1909

TABLE 074 THE SURVIVAL OF VIBRIO SPECIES IN CULTURE

* Factor(s)	Survival	Reference
SOLID, CONT.		
<u>V. comma</u>		
10 cc. agar, 38 C., plus		
.46 gm. NaCl & .05 $Ca(NO_3)_2$	Dispersed invol. forms.	Eisler 1909
.4 gm. NaCl & .1 Gm. $Ca(NO_3)_2$	Normal	"
0.1 gm. LiCl	Many invol. forms.	"
0.1 g. LiCl & .05 g. $Ca(NO_3)_2$	Many normal, some invol.	"
.05 g. $Mg(NO_3)_2$	Invol. & normal	"
.05 g. $Mg(NO_3)_2$ & 1g. NaCl	Many normal, few invol.	"
Thiol, 26 C., pH 6.8	At least 150 d., Max. growth 4 d.	Huddleson 1949
Beef peptone gelatine cult.		
-12.5 C., indoors	Lived 2 wks. after.	Kasanky 1895
-31.8 C., outdoors	Lived 20 d.	"
-30 to -31.8 C.	Viable 114 d.	"
Gelatine cult., 102 d. old.		
Dried in air	2 d.	Kitasato 1889
" "	30 h.	"
Dried in exicator	5 d.	"
" "	40 h.	"
Gelatine cult. 12 d. old.		
dried in air	3 d.	"
dried in exicator	3 d.	"
Gelatine cult. 4 d. old.		
dried in air	4 d.	"
dried in exicator	5 d.	"
Agar cult. 20-22 C., 14 mos. old, 10 d. in incubator. Dried in air	4 d.	"
" " Dried in exicator	7 d.	"
Agar cult. 20-22 C. 50 d. old, 12 d. in incub.		
dried in air	4 d.	"
dried in exicator	11 d.	"
Agar cult. 20-22 C., 9 d. old., 1 d. in incub.		
dried in air	4 d.	"
dried in exicator	9 d.	"
Agar cult. 20-22 C., 1 d. old., 1 d. in incub.		
dried in air	3 d.	"
dried in exicator	11 d.	"
Potato cult, 17 d. old. 8 d. in incub.		
air dried	2 d.	"
dried in exicator	5 d.	"
Potato cult. 8 d. old, 8 d. in incub.		
air dried	4 d.	"
dried in exicator	5 d.	"

TABLE C 24 THE SURVIVAL OF VIBRIO SPECIES IN CULTURE

Factor(s)	Survival	Reference	
SOLID, CONT			
V. comma			
Gelatine agar, liquid air, -190 C.	No impaired vitality 7d	MacFayden	1900
Agar slant	42 d.	Tohyama	1925
GENERAL			
V. comma			
Stock lab. cult., R.T., sealed	Failed to show growth after 12-18 yrs.	Ahuja	1935
-40 F.	425 d.	Cole	1951
45 F., thawed and held 61-105 d.	Lasting immunity when used with hog cholera antisera	"	
-5.5to -8 C.	Recov. 0, 10 d.	Finkelburg	1901
- (Bombay str.)	> 524 d.	Lal	1921
- (Hog cholera)	> 657 d.	"	
20 C. exposed to polarized light	Innoc. 1/100,000 diln. Recov. 121, 13 hrs.	"	1926
24 C., Exp. to unpolar. light	Innoc 1/100,00 diln., Recov. 17, 30 h.	"	
105 C.	Living	Lal	1923
110 C.	Dead	"	
Dark, R.T.	1,044 d.	"	
-21 C.	1 mo.	Rapschewski	1901
-15 C.	>1 mo.	"	
37 C.	dead at 2 yrs.	Rhodes	1950
Stored at 37 C.	0% survive after 4 yrs.	Stamp	1947
Lives more than 1 mo. when lowest temp. is -32.5 C. and repeated freezing & thawing has not infludnee on vitality.		Wuknow	1893

TABLE (25) THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference
DRIED, GENERAL		
Allantoid		
Dried & ppt. at 4 C.	6 mo..	Fasquelle 1950
Aphteuse		
Dried & left at 37 C.	2 yrs.	"
Herpes febrilis		
Ice box dried in vacuum over H_2SO_4 with reduced press., -5 C., Recov. in Lockes soln.	>1 yr.	Hawkins 1929
Herpetique		
Dried & left at 37 C.	2 mo.	Fasquelle 1950
Hoof & Mouth		
Dried with 0.5 g. P_2O_5 at 70 C. in vacuo	$2\frac{1}{2}$ hrs.	Sichert-Modrow 1930
Lymph, 122 C., dried with 0.5 g. P_2O_5 in vacuo.	3 min.	"
Dried lymph of G.P., 52 C. in atm. of P_2O_5.	Still infectious, 14 h.	"
" " " R.T.	10 d.	"
Influenza (Melbourne str.)		
Dried talc	30 min.	Parker 1944
Polio, (Aycock str.)		
Heat 30 min. at 50 C.	Remained infective	Shaughnessy 1930
" " 52.5 C.	Non-infective	"
Smallpox		
37 C., dried	80 d.	Hornibrook 1951
4-6 C., dried	24 h.	"
Tobacco mosaic		
Dessicated	many yrs.	Stakman 1942
Vaccinia (testicular str.)		
Dried, 4 C.	12-18 mos.	Noguchi 1918
Dried	229 d.	Paschen 1908
DRIED, LYOPHILIZED		
Foot & mouth		
Dried in vacuo & refrig.	93 d.	Lepine 1937
Herpes		
0.5 fresh brain emuls. with Lockes soln.	4 wks.	Rivers 1927
Influenza		
Lyophilized	Infect. for ferret 14 mos.	Horsfall 1940
Infusion broth, rabbit testis, -78 C.	3 yrs.	Turner 1939
Mouse lung, 10% plain broth, -78 C.	6 mos.	Turner 1938
Laryngotracheitis (fowl)		
Lyophil. & stored 4 C.	3 yrs.	Hoffstadt 1946
Lymphogranuloma inguinale		
Infusion broth, rabbit testes, -78 C.	10 mos.	Turner 1939
Lymphocytic choriomeningitis		
Frozen, dried, 5 C.	378 d.	Wooley 1939

TABLE C 25 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
DRIED, LYOPHILIZED (cont'd)			
Meningopneumonitis			
Infusion broth, rabbit testes, -78C	3 yrs.	Turner	1939
St. Louis encephalitis			
Frozen, dried, 5C	833 d.	Wooley	1939
Vaccinia			
Frozen, dried	mos.	"	"
Lockes soln., -185C			
Frozen & thawed 22X	No reaction, rabbit skin	Rivers	1927
Lyophil apparatus appears to be useful also in maintaining the viability of virus strains without continuous animal passage. (10 mos.)		Flosdorf	1935
LIQUID			
Coxsackie			
Susp., 53-55C	30 min.	Robinson	1950
" pH 2.3-9.4	1 d.	"	"
" pH 4.8	7 d.	"	"
Enteritis			
PO_4 buffer, pH 7	<20 d.	Gallo	1948
1/1,000 dil.	Killed 75% of mice	"	"
1/10,000 dil.	" 25% " "	"	"
1/100,000 dil.	None killed	"	"
Equine encephalitis			
Acidic saline with agitation, bubbling, gases & shaking, pH 6.4	Rapidly inactivated	McLimans	1947
Foot & mouth			
GP blood 37C, citrated	4.9 d.	Brooksby	1948
" " " defibrinate	2.1 d.	"	"
M/45 buff. PO_4 soln., OC pH 7.6, purified	Inoc. dil. 1/100,000 Recov. dil. 1/100, 97 d.	Galloway	1936
pH 7.6, unpurified	Inoc. dil. 1/100,000 Recov. dil. 1/1,000, 126 d.	"	"
Saline, 37C	24 hrs.	Lepine	1937
50% glycerine	174 d.	"	"
GP lymph., pH 7.5 in PO_4 buffer.	Still infectious, 2 yrs. 20 d.	Sichert-Modrow	1930
Ammonia brine, repeated freezing	Did not destroy, 124 d.	Stockman	1926
Fresh GP lymph, 2-7C	Retained virulence 190 d.	"	"
Herpes			
20% susp. of infected rabbit brain in buff. physiol. saline, 37C	100 hrs.	Boak	1940
" " " 41.5C	70-80 hrs. (Frank str.)	"	"
" " " "	30 hrs. (Go str.)	"	"
Fresh normal rabbit serum with UV radiation	10 min.	Gundersen	1932
Tissue cult., 40.2C	Did not survive	Thompson	1942

TABLE 025 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, (CONT.)			
Influenza			
Single heat, chorio-allantoic fluid, (PR 8 unadapted) 60 C.	<5 min.	Jones	1945
Single heat, chorio-allantoic fluid, (PR 8 Heat adapted) 60 C.	<5 min.	"	
" " " 56 C.	>45 to <60 min.	"	
Mouse brain susp. with rabbit serum, -20 to -30 C. (A & D)	<6 mos.	Olitsky	1949
Saline & horse serum			
" " " pH 3.05	1 h.	Stock	1940
" " " " 4.04	1-20 h.	"	
" " " " 4.99	48 h.	"	
" " " " 5.35	48 h.	"	
" " " " 5.98	>72 h.	"	
" " " " 6.98	72 h.	"	
" " " " 7.0	72 h.	"	
" " " " 5.0	1 h.	"	
" " " " 7.5 with .001 M. oleic acid.	90 min.	"	
50% glycerine	3-4 wks.	Wilson	1919
Japanese B. encephalitis			
Mouse brain susp. with rabbit serum, -20 to -30 C.	6 mos.	Olitsky	1949
Lymphogranuloma inguinale			
Aqueous susp.	40 hrs.	Latarjet	1951
Measles			
50% glycerine	3 mos.	VanRooyen	1940
Mumps			
Mouse brain susp. with rabbit serum, -20 to -30 C.	< 6 mos.	Olitsky	1949
Chorio-allantoic fluid, 4 C., pH 6.5-7	Most stable	Weil	1948
Chorio-allantoic fluid, 4 C., pH above 7.9	Rapidly killed	"	
Chorio-allantoic fluid, 4 C., pH 5.8-8	99% inact., 4 wks.	"	
Penicillin & streptomycin	No inact. effect 14-28 d.	"	
Chorio-allantoic fluid, 37.5 C.	Greatest & most rapid increase, 7 d.	"	
Myxoma			
Tissue cult., 42.2 C.	Did not survive	Thompson	1942
Neurotropic			
Mouse brain susp. with rabbit serum, -20 to -30C.	9 mos.	Olitsky	1949
Newcastle			
50% glycerine, R.T., pH 7.6	95 d.	Prier	1950
" " 5C, "	353 d.	Prier	1950

TABLE C 25 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, (CONT.)			
Noguchi Str. (Vaccinia)			
Tissue cult., 45.1 C.	<4 d.	Thompson	1942
Poliomyelitis			
Glycerol	6 yrs.	Flexner	1917
Spinal cord in 50% glycerol, 4 C.	>25 mos.	"	1914
Glycerol (M.A. str.)	>11 mos.	"	
0.5% phenol	>14 d.	"	
Filtered, 37 C.	20 d.	"	1910
-2 to -4 C.	40 d.	"	
4 C.	50 d.	"	
45-50 C.	Killed after 30 min.	"	
50% glycerol	>7 d.	"	
" " -15 C.	2 yrs.	"	
Aqueous susp.	10 d.	Latarjet	1951
Physiol. saline, 45-60 C. 30 min.	Becomes inactivated. The more dil. the susp. the less heat is req. to inactivate.	"	
50% glycerol	8 yrs.	Rhoads	1929
100 % glycerol, 18 C. 1st passage.	Viable 59 d.	Romer	1910
50% glycerol, 3rd pass.	14-31 d.	"	
50% glycerine	Some mos.	Wilson	1919
Psittacosis			
Beef saline	29 d.	Rivers	1948
Rabies			
Brain susp. in glycerine in disintegrator 1 h.	47 d.	Barrat	1904
Susp. brain, liquid air	Still virulent 24 h.	"	
Buffer soln., glycerol	15-17 wks.	Grycz	1949
Aqueous susp.	40 hrs.	Latarjet	1951
Undil. neutral glycerol, R.T.	Several wks.	Rivers	1948
Liquid air, -185 C.	3 mos.	McFayden	1900
Neutral glycerol, refrig.	Several mos.	Rivers	1948
Aqueous susp., 54-56 C.	1 h. or less	"	
" " sub-freezing.	1 or more yrs.	"	
Streptobacillus virus			
Bouillon, 100 C., 48 h. cult., 1-100 dil. (Str. # 1776)	No growth	Bingel	1947
Vaccinia			
Glycerine susp. (28628, rabbit testicular)	33 d. & 6 hrs. after 61st transfer	Armstrong	1929
Chorio-allantoic memb.	8 hrs.	Buchbinder	1941
Glycerine, mouse brain, water	Inoc. .05 cc of 1:100 dil., Recov. after 24th passage, 10 mos.	Haagen	1939
Glycerine, mouse brain, water, freeze-dry temp.	1 yr. 9 mos.	"	
Glycerine, mouse brain, refrig. temp.	Avirulent 1 yr.	"	

TABLE C25 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
LIQUID, CONT.			
Vaccinia			
Chorion & 1 drop calf lymph, Refrig. temp. (Str. 3, Breslau)	2 yrs.	Haagen	1939
(Str. 4, Dresden)	"	"	
Allantois of chick embryo, low temp., Present in glycerine, Ringers soln. from 1933-49	Capable of multiplication and still pathogenic after 15 yrs.	Lehmann	1949
Pure glycerol, 18 C.	5 d.	Noguchi	1918
" " 37 C.	24 h.	"	
Ringers soln. with .54 and 1% phenol and water	Still active 1 yr.	"	
Physiol saline, -13 C.	7.4% showed count over 30,000 after 4 yrs. 41 % after 10 yrs.	Schartner	1939
Tissue cult., 45.1 C.	-	Thompson	1942
Liquid air	15 min.	White	1901
Variola			
Saline soln., 35 C.	30 min.	Gordon	1925
Yellow fever			
Physiol. saline	Better than dist. water.	Bauer	1940
Aqueous susp.	10 d.	Latarjet	1951
Glycerol	8 mos.	Rivers	1948
SOLID			
Foot & mouth			
Congealed state	162 d.	Lepine	1937
Vaccinia			
Levinthal, blood agar, -13 C.	Recov. 11% after 4 yrs., 58.3% after 10 yrs.	Schartner	1939
GENERAL			
Colorado tick fever			
Ice compartment	3½ yrs.	Rivers	1948
Cow pox			
Culture, -70 C.	< 108 h.	Pictet	1884
" -130 C.	< 20 h.	"	
Dengue			
Stegomya, 22 C.	Up to 85 d.	Blanc	1929
" 16.5 C.	" "	"	
" 22.5 C.	Up to 174 d.	"	
Encephalitis			
40 C., pH 8.4 (St. Louis)	Still visble 3 wks.	Duffy	1946
pH 3.5-11.5 (Equine)	Greatest stability after 1 h.	Finkelstein	1938
pH 7.5-8.5, (Equine)	Greatest stability " 1 wk.	"	
20% saline with 10 cc. defibrin. rabbit blood temp 29.4-32 C., high humidity (Jap. B.)	Transmission occurred by bite of Culex spp. mosq. in 8 days following blood meal	Hammon	1949

TABLE C 25 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL			
<u>Encephalitis</u>			
-20 C., glass tubes (Jap B.)	12 mos.	Melnick	1946
-20 C., corked tubes (Jap B.)	1000 fold loss	Melnick	1946
Filtered, 56 C. (St. Louis)	30 min.	Rivers	1948
pH 8.4-8.8 (St. Louis)	3 wks.	"	
pH 7-10 (Jap B)	Inact. rapidly	Rivers	1948
Susp. 70 C. (West. equine)	10 min.	"	
Filtrates, 60 C. " "	10 min.	"	
<u>Fowl plague</u>			
pH 6-99	Range of stability	Pyl	1938
<u>Foot & mouth</u>			
Guinea pig vesicle fluid, R.T.	3-6 mos.	Anonymous	-
<u>Herpes simplex</u>			
-70 C.	> 1 yr.	Rivers	1948
<u>Influenza</u>			
10% normal horse serum, shaken 24 h. (PR8 Str.)	Held titer better than 0.2% bovine albumin	Dick	1949
10% normal monkey serum, shaken 24 h. (French neurotropic)	Held titer better than 0.2% bovine albumin dil.	"	
Tissue culture, 60 C. (PR8)	>5 min, <7 min	Jones	1945
" " 55 C.	>30 min, <45 min.	"	
" " 50 C.	>120 min, < 180 min.	"	
Tissue culture, heat adapted, 60 C.	>5 min, <7 min.	"	
" " 55 C.	>45 min, <60 min.	"	
" " 50 C.	>180 min.	"	
After storage, (PR 8) 25.5 C.	Unadapted 28 d., heat adapted 49 d.	"	
" " 37 C.	Unadapted 18 d., heat adapted 22 d.	"	
" " 41 C.	Unadapted 8 d., heat adapted 14 d.	"	
40 C. (Inf. A)	2-3 mos.	Rivers	1948
R.T.	6 wks	Scherp	1938
0-40 C.	1 wk.	"	
<u>Inclusion conjunctivitis</u>			
Refrigerated	Sev. days	Rivers	1948
<u>Looping ill</u>			
Mouse brain, 80 C.	30 sec.	"	
" " 60 C.	2 min.	"	
" " [illegible]	10 min	"	
<u>Lymphogranuloma [illegible]</u>			
37 C.	2-4 d.	"	
56 C.	10 min.	"	
70 -- 30 C.	>1 yr.	"	

TABLE C-25 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference
GENERAL		
Mumps		
-70 C.	10 mos.	Rivers 1948
Measles		
-72 to -35 C.	4 wks.	Rivers 1948
Freezing	25 hrs.	Van Rooyen 1940
Newcastle		
pH 5.5-7.5	-	Elford 1948
Incub. 37 C., undil. amniotic fluid	Viable 126 d.	Olesiuk 1951
Papilloma		
Neutral to pH 4.2	Least loss of activity.	Beard 1938
weakly alkaline	Gradual loss of activ.	"
On acid side of pH 7 the virus activity remains high until at pH between 2.9 & 3.3 it is lost suddenly. At pH 10.1 to 10.2 immediate inactiv. observed. (Shope virus)		Wyckoff 1937
Poliomyelitis		
More effective when suspended in low pH.	(Armstrong mouse adapted)	Hammon 1941
Infective after heating at 55-58 C.	-	Howitt 1930
Emulsion of hemoceles of flies & cockroaches	Produced paralysis in mice in 12 & 15 d. respectively.	Hurlbut 1950
<38.5 C., 2800-3100 Å.	Complete destruction 1-30 min.	Jungleblut 1937
Berkefeld filter, 38 C.	7 d.	Landsteiner 1910
35 C.	2 hrs.	Leiner 1910
37 C.	21 d.	Levaditi 1913
-70 to -20 C.	No loss in infectivity 12 mos.	Melnick 1946
With E. histolytica	Settles out	Young 1949
50 C.	3 min.	Shaughnessy 1930
Pseudolymphocytic chorio meningitis		
Mouse brain, 56 C.	30 min.	Rivers 1948
Psittacosis		
Broth, 40 C.	Several wks.	Rivers 1948
-70 C.	>2 yrs.	"
Rabies		
Fats & lipids extracted from dessicated rabies vaccine with various solvents and injected into mice fail to give protection or provoke evidence of toxic response when given subdurally or intraperitonally. When extracted at low temp (-65 C.) with ether, the virus is not destroyed. After 1 yr. amount of living virus has not decreased.		Harris 1948
Rift valley fever virus		
Light, met. blue	40 min.	Rivers 1948
Rinderpest virus		
Leucocytes & spleen 4 C. Dried & ppt. with acetone.	>2 mos.	Das 1949

TABLE 125 THE SURVIVAL OF VIRUSES IN CULTURE

Factor(s)	Survival	Reference	
GENERAL, CONT.			
<u>Rinderpest virus</u>			
Leucocytes & spleen 40 C.	>4 mos.	Das	1949
Dried over $CaCl_2$ in vacuo.			
" " " " 37 C.	15 d.	"	
<u>Semlike forest virus</u>			
60 C.	1 h.	Rivers	1948
<u>Trachoma</u>			
Refrigerate	1 wk.	Julianelle	1942
<u>Vaccinia</u>			
Ottens d., [illegible], tropical temp and R.H.	18 yrs.	Collier	1950
Gases at 4 C.	Retained virulence 3wks.	Noguchi	1918
Gases at 37 C.	Became avirulent	"	
Pure O_2 or CO_2, 18 C.	Destroyed virus complete.	"	
Sonic vibrations	>15 min. partial inact.	Rivers	1937
<u>Yellow fever</u>			
10% N. monkey serum shaken 24 h.	Held titer better than 0.2% bovine alb. dil.	Dick	1949
Dessicated, frozen	many yrs.	Rivers	1948
<u>Cold virus filtrates.</u>			
-76 C., dry ice	2 yrs.	Andrews	1949
-10 C.	27 d.	"	
4 C.	3 d.	"	

TABLE C26 THE SURVIVAL OF YEASTS, MOLDS AND FUNGI IN CULTURE

Factor(s)	Survival	Reference	
DRIED, GENERAL			
Actinomyces			
Dessicated (wentii)	>1 yr.	Wehmer	1897
" (niger)	3 yrs.	"	
" (oryzae)	>4 yrs.	"	
Dried (spp.)	4-5 yrs.	Proom	1949
Brewers yeast			
Dried with plaster paris	10 mos.	Pasteur	1876
Saccharomyces pastorianus			
Diffuse light	< 3 yrs.	Kayser	1889
Yeast, spp.			
More resistant in dry state than in moist.		Kayser	1889
DRIED, LYOPHILIZED			
Ascomycetes			
Culture suspended in normal horse serum, quick frozen, dried in high vacuum & sealed quickly	0.2% survival rate in 3 mos.	Atkin	1949
Saccharomyces cerevisiae			
Bouillon & beerwort, exp 10-15 min. to U.V.	More time req. for gelatinized media	Gilles	1935
Frozen at -24 C. & thawed a5 25 C.	28% killed	Stille	1943
Yeasts, spp.			
Lyophilized in vacuo	1 yr.	Dopter	1949
Lyophilized	2 yrs.	Wickerham	1946
LIQUID			
Aspergillus			
Nutrient media, -6 to -11 C.	4 d.	Bartetzko	1910
1% glucose, -12 C.	2 h.	"	
Epidermophytes			
.85% NaCl, -20 to -30 C.	34 d.	Kadisch	1931
Saccharomyces			
Broth, salt soln., -13 to -15 C. (cerevisiae)	>160 wks.	Tanner	1928
Broth, -13 to -15 C. (ellipsoideus)	5 wks	"	
Salt soln., -13 to -15 C. (ellipsoideus)	18 wks.	"	
Broth, -13 to -15 C. (maxicans)	>160 wks.	"	
Salt soln., -13 to -15 C. (maxicans)	14 wks.	"	
Broth, -13 to -15 C. (pastorianus)	58 wks.	"	
Salt soln., -13 to -15 C. (pastorianus)	>160 wks.	"	
Yeasts, spp.			
10% sucrose	Of 25 strs., 15 retained viability 10¼ yrs., 9 dead in 8¼ yrs.	Meissner	1911
Nutrient broth & fruit juices, -23.3 C.	3 yrs.	Tanner	1934

TABLE C26 THE SURVIVAL OF YEASTS, MOLDS AND FUNGI IN CULTURE.

Factor(s)	Survival	Reference	
LIQUID, CONT.			
Yeasts, spp.			
10% sucrose in Freudenreich flasks	many yrs.	Will	1909
.85% NaCl soln., -20 to -30 C.	>2 mos..	Kadisch	1931
SOLID			
Absidia			
Potato dextrose agar, 7C.	10 used, 8 viable, 2 yrs. 8 mos.	Hesseltine	1947
Actinomucor			
Potato dext. agar, 7 C.	1 used, 1 viable, 2 yrs. 8 mos.	"	
Alternaria			
Potato dext. agar, 7 C.	3 used, 3 viable, 2 yrs. 8 mos.	"	
Agar slant, -29 C.	>4 mos.	Bartram	1916
Ascophyta			
Agar slant, -29C.	>4 mos.	"	
Aspergillus			
Potato dext. agar, 7 C.	98 used, 48 viable, 2 yrs., 8 mos.	Hesseltine	1947
3% gelatin, -10 to -13 C.	12 h.	Lindner	1915
Blastomyces			
Sabourauds dextrose agar, R.T., cov. with mineral oil.	20 mos.	Ajello	1951
Candida			
Sabourauds dextrose agar, R.T., cov. with mineral oil	20 mos.	"	
Cephalotheuum			
Agar slant, -29 C.	> 4 mos.	Bartram	1916
Chartomium			
Potato dext. agar, 7 C.	8 used, 7 viable, 2 yrs., 8 mos.	Hesseltine	1947
Circinella			
Potato dext. agar, 7 C.	2 used, 2 viable, 2 yrs., 8 mos.	"	
Coccidioides			
Sabourauds dext. agar, R.T., cov. with mineral oil.	20 mos.	Ajello	1951
Cryptococcus			
Sabourauds dext.agar,R.T. cov. with mineral oil	20 mos.	"	
Fusarium			
Potato dext. agar, 7 C.	15 used, 11 viable 2 yrs., 8 mos.	Hesseltine	1947
Mucor			
Agar or liquid Raulins med., -70 to -110 C.	2 h.	Chodat	1896

PLATE C26 THE SURVIVAL OF YEASTS, MOLDS AND FUNGI IN CULTURE

Factor(s)	Survival	Reference
SOLID		
Mucor		
Potato dext. agar, 7 C.	59 used, 53 viable, 2 yrs, 8 mos.	Hesseltine 1947
Nocardia		
Sabourauds dext. agar, R.T. Cov. with mineral oil.	20 mos.	Ajello 1951
Phycomyces		
Potato dext agar, 7 C.	3 used, 3 viable, 2 yrs., 8 mos.	Hesseltine 1947
Penicillium		
Potato dext. agar, 7 C. (spp.)	2 yrs., 8 mos.	"
3% gelatin, -10 to -13 C (glaucum)	12 h.	Lindner 1915
Rhizopus		
Potato dext. agar, 7 C.	17 used, 13 viable 2 yrs., 8 mos.	Hesseltine 1947
Saccharomyces cerevisiae		
Agar slants, -70 C.	1-8 d.	Karcher 1931
Syncephalastrum		
Potato dext. agar, 7 C.	2 used, 2 viable, 2 yrs. 8 mos.	Hesseltine 1947
Trichoderma		
Potato dext. agar, 7 C.	7 used, 7 viable 2 yrs. 8 mos.	"
Yeast, spp.		
Nutrient agar, 0 C	Rapid growth, 5 d.	Haines 1934
GENERAL		
Aspergillus		
Dark, lab. temp. (flavus)	6 yrs.	McCrae 1923
" " (fumigatus)	10 yrs.	"
" " (glaucus)	16 yrs.	"
Mold, spp.		
Dark, lab. temp. (spores)	20 yrs.	"
Below freezing	Very few living, 16 mos	Tanner 1931
Saccharomyces		
Subfreezing temp, Sucrose conc. >30-35%, pH 3.6-3.7	Retards destruction	McFarlane 1940
Streptothrix		
-	420 d.	Lal 1921
Yeasts, spp.		
Incubator, 28 C.	< 3 yrs.	Kayser 1889
Sub-freezing, -9.9 C. in agar slant	> 1 yr.	Smart 1935
Found in frozen fruits, 15 F.	After 3 yrs.	"
-15 C.	160 wks.	Tanner 1928
Yeasts, spp.		
Agar, 37 C.	5 mos.	Eberson 1920

References (Culture)

1. Abel, R. 1893 Beitrag zur Frage von der Lebensdauer die Diphtheriebacillen. Centr. Bakt., 14, 756-761.
2. Abel, R. 1895 Versuch über das Verhalten der Diphtheriebacillen gegen die Einwirkung der Winterkälte. Centr. Bakt., 1.Abt. (Orig.), 17, 545-550.
3. Abel, R. 1897 Zur Kenntnis des Pestbacillus. Centr. Bakt., 21, 497-517.
4. Ahuja, M.L. 1935 Viability of bacterial cultures. Indian J. Med. Research, 22, 477-478.
5. Ajello, L., Grant, V., and Gutzke, M. 1951 Use of mineral oil in the maintenance of cultures of fungi pathogenic for humans. Arch. Dermatol. Syphilol., 63, 747-749.
6. Albert, J.O., Long, H.F., and Hammer, B.W. 1944 Classification of the organisms important in dairy products. IV. Bacterium linens. Agric. Expt. Station Iowa State College of Agriculture and Mechanic Arts, Res. Bull. No. 328, 234-259.
7. Alicante, M.M. 1926 The viability of the nodule bacteria of legumes outside of the plant. III, IV, V. Soil Sci., 21, 93-114.
8. Allen, P. 1923 The attenuation of bacteria due to temperature shock. J. Bact., 8, 555-566.
9. Anderson, C.R. 1944 Survival of rickettsia in different diluents. J. Bact., 47, 519.
10. Anderson, T.F., Boggs, S., and Winters, B.C. 1948 The relative sensitivities of bacterial viruses to intense sonic vibration. Science, 108, 18.
11. Andrewes, C.H. 1949 The natural history of the common cold. Lancet, 256, 71-75.
12. Andrews, W., Dobson, N., Bannatyne, T., Davies, G., Simmins, G., Watkins, C., and Evans, J. 1931 Rep. Ft. and Mth. Disease Comm., London, No. 4.
13. Anjow, S. 1928 Resistance of various spirochetes to external influence. Centr. Bakt. (Abt. 1), 109, 61-80.
14. Arai, H. 1931 Viability of bacteria in cold store of the "Mamiya", a provision deport boat. Bull. Nav. Med. Assoc., Japan, 20, 2.
15. Arguelles, M.V. 1927 Viability of Cholera vibrio in various menstrua. Rev. Filipina de Med. y Farm., 18, 137-140.
16. Arloing, N.I. 1885 Compt. rend. soc. biol.
17. Armstrong, C. 1929 The selection of a heat-resistant strain of vaccine virus (rabbit testicular). U.S. Pub. Health Repts., 44, 1183.
18. Atkin, L., Moses, W., and Gray, P.P. 1949 The preservation of yeast cultures by lyophilization. J. Bact., 57, 575-578.
19. Bachmann, E., and Lodenkämper, H. 1943 Versuche ueber die Lebensfahigkeit von Erregern der bakteriellen Ruhr bei Verwendung von Brot als Keimträger. Arch. Hyg. Bakt., 130, 77-84.
20. Ballantyne, E.N. 1930 On certain factors influencing the survival of bacteria in water and in saline solutions. J. Bact., 19, 303-320.
21. Barrat, J.O.W. 1904 Centrifugalization and disintegration in relation to the virus of rabies. Centr. Bakt., I Abt. Orig., 35, 633-640, 769-795.

22. Bartel, J., and Neumann, W. 1908 Das Verhalten der Tuberkelbacillen in "indifferenten" Flussigkeiten. Centr. Bakt., I Abt., Orig., 47, 401, 572, 414, 579.
23. Bartetzko, H. 1910 Jahrb. F. Wiss. Bot., 47, 57-98.
24. Bartram, H.E. 1916 J. Agr. Res., 5, 651-655.
25. Basset, J., and Macheboeuf, M.A. 1932 Resistance of bacteria to very high pressure. Compt. rend. acad. sci., 195, 1431-1433.
26. Basset, J.M., Macheboeuf, M., and Wollman, E. 1937 Researches on pathogenic microbes and their toxins, on invisible viruses, a bacteriophage and malignant tumors. Ann. Inst. Pasteur, 58, 58-77.
27. Bauer, J.H., and Pickels, E.G. 1940 An apparatus for freezing and drying virus in large quantities under uniform conditions. J. Exp. Med., 71, 83-88.
28. Bazzoni, C.B. 1914 The destruction of bacteria through the action of light. Am. J. Pub. Health, 4, 975-992.
29. Beard, J.W., and Wyckoff, R.W.G. 1938 The pH stability of the papilloma virus protein. J. Biol. Chem., 123, 461.
30. Beard, J.W., Finkelstein, H., and Wyckoff, R.W.G. 1938 The pH stability of the elementary bodies of vaccinia. J. Immunol., 35, 415-425.
31. Beck, M.D. 1937 California field and laboratory studies on relapsing fever. J. Infectious Diseases, 60, 64-80.
32. Becquerel, P. 1910 Compt. rend. acad. sci., 86.
33. Belin, M., Mutermilch, S., and Salamon, E. 1933 Effect of protective substances on heat resistance of certain bacteria. Compt. rend. soc. biol., 114, 1278-1281.
34. Bellelli, F. 1928 Survival of anthrax bacilli with other germs; implantation at different times; spore formation. Folia Med., 14, 1325-1344.
35. Beltencourt, A., Franca, C. 1904 Ueber die Meningitis cerebrospinalis epidemice und ihren specifischen Erreger. Z. Hyg. Infektionskrankh., 46, 463-516.
36. Berry, H., and Michaëls, I. 1948 Evaluation of bactericidal activity of ethylene glycol and mono-alkyl ethers against Bacterium coli. V. Quart. J. Pharm. Pharmacol., 21, 503-518.
37. Bessemans, N.I., Vergouille, N.I., and Hacquert, N.I. 1930 Balneotherapy in syphilis. J. Am. Med. Assoc., 94, 1251-1252.
38. Best, R.J. 1948 Longevity of tobacco mosaic virus I. In vitro life of the pure virus in buffer solution at pH 4. Australian J. Exp. Biol. Med. Sci., 26, 163-169.
39. Bingel, K.F. 1947 Comparative studies on heat sensitivity of virus associated with streptococci and of direct erythrogenic scarlet fever agent. Z. Hyg. Infektionskrankh., 127, 280-285.
40. Birkhaug, K. 1951 Influence of storage on viability of BCG vaccine. Proc. Soc. Exp. Biol. Med., 76, 311-312.
41. Blanc, G., and Caminopetros, J. 1929 Life time of dengue virus and effect of cold season on its virulence in Stegomyia. Compt. rend. acad. sc., 188, 1273-1275.
42. Bloch, O., Jr. 1941 Loss of virulence of Treponema pallidum in citrated blood at 5C. Bull. Johns Hopkins Hospital, 68, 412-415.

43. Boak, R.A., Carpenter, C.N., and Warren, S.L. 1933 The in vivo thermal death time of Treponema pallidum. J. Bact., 25, 93.
44. Boak, R., Carpenter, C., and Warren, S.L. 1940 The thermal inactivation time at 41.5C of three strains of herpes simplex virus. J. Exp. Med., 71, 169.
45. Bolten, J. 1918 Effect of freezing on organisms of typhoid and diphtheria. Pub. Health Rep., 33, 163.
46. Boquet, A. 1943 The vitality of virulent tubercle bacilli. Compt. rend. soc. biol., 137, 443.
47. Borman, E.K. 1932 Comparative studies on natural and acquired resistance of strains of coli bacteria to bacteriostatic and germicidal effects of cations. J. Bact., 23, 315-329.
48. Bourn, J.M., and Carnes, C.M. 1947 The use of dried antigen preparations for testing pneumococcus typing sera. J. Lab. Clin. Med., 32, 104-106.
49. Bovarnick, M.R., Miller, J.C., and Snyder, J.C. 1950 The influence of certain salts, amino acids, sugars, and proteins on the stability of ridkettsiae. J. Bact., 59, 509-522.
50. Boventer, K. 1947 Uber die Lebensdauer von Tetanussperen. Zugleich ein Beitrage zur Frage des Spattetanus. Arztl. Wochschr., 1947, 792.
51. Brehme, W. 1901 Arch. Hyg., 40, 320-346.
52. Bronfenbrenner, N.I., and Noguchi, H. 1913 On the resistance of the various spirochetes in cultures to the action of various chemical and physical agents. J. Pharmacol. Exp. Therap., 4, 333.
53. Brooksby, J. 1948 The survival of the virus of foot-and-mouth disease in blood at 37C. Brit. J. Exp. Path., 29, 10-19.
54. Brown, J.G. 1930 Living microorganisms in the air of the arid southwest. Science, 72, 322-323.
55. Bruynoghe, R., and Mund, W. 1925 Action of radium on microbes. Compt. rend. soc. biol., 92, 211-212.
56. Bruynoghe, L., and Mund, W. 1925 Irradiated microbes and bacteriophage. Compt. rend. soc. biol., 92, 464-465.
57. Buchbinder, L., Solowey, M., and Solotorovsky, M. 1941 Studies on microorganisms in simulated room environments. IV. The effect of survival on the pathogenic properties of streptococci: mouse virulence. J. Bact., 42, 615-630.
58. Buchbinder, L., and Solotorovsky, M. 1941 Studies on microorganisms in simulated room environments. VI. The disappearance of vaccinia virus from the air. J. Bact., 42, 635-641.
59. Bullock, K., and Lightbown, J.W. 1947 II. Effects of drying on the viability of bacteria and their thermolability in powders. Quart. J. Pharm. Pharmacol., 20, 312-328.
60. Burke, V., Sprague, A., and Barnes, LaV. 1925 Dormancy in bacteria. J. Infectious Diseases, 36, 555-560.
61. Burling, H.A., and Levine, S.B. 1918 Concentration of glucose and lactose and viability of coli-like bacteria. Am. J. Pub. Health, 8, 306-307.
62. Cameron, H.S. 1932 The viability of Brucella abortus. Cornell Vet., 22, 212-224.

63. Campbell-Renton, M.L. 1942 The recovery of cholera vibrios after drying. J. Path. Bact., 54, 121-125.
64. Carpenter, C.M., Boak, R.A., Mucci, L.A., and Warren, S.L. 1933 Studies on the physiologic effects of fever temperatures. The thermal death time of Neisseria gonorrheae in vitro with special reference to fever temperatures. J. Lab. Clin. Med., 18, 981-990.
65. Chapman, G.H. 1936 Studies of streptococci. IV. Resistance of enterococci. J. Bact., 32, 41-46.
66. Chodat, R. 1896 Bull. Herb. Boisier, 4, 890-897.
67. Citoviez, B. 1928 Transformation of hemolytic streptococci to "viridans" streptococci by cooling. Compt. rend. soc. biol., 99, 1699-1700.
68. Clark, H.W., and Gage, S. de M. 1903 34th Ann. Rep., State Board of Health, Mass., 245.
69. Clifton, C.E. 1931 Photodynamic action of certain dyes on the inactivation of staphylococcus bacteriophage. Proc. Soc. Exp. Biol. Med., 28, 745-746.
70. Cohn, F. 1872 Beitr. Z. Biol. Pflanzen, 1, 121-221.
71. Cohn, M.L. 1939 Preservation of tubercle bacilli. Am. Rev. Tuberc., 40, 99-108.
72. Cole, C.G., and Henley, R.R. 1951 Preservation of hog cholera virus at low temperatures. Vet. Med., 46, 180-183.
73. Collier, W.A. 1950 Preservability of dry vaccine lymph. Documenta Neerland. et Indonesica Morbis Trop., 2, 41-43.
74. Cooper, H.J., and Gauss, H. 1923 The preservation of cultures of human and bovine tubercle bacilli. Am. Rev. Tuberc., 6, 1040.
75. Cordova-Marquez, R. 1949 The effect on toxin production and growth of passing CO_2 through deep broth cultures of Corynebacterium diphtheriae. Dissertation: Univ. of Michigan.
76. Corper, H.J., and Cohn, M.L. 1933 The viability and virulence of old cultures of tubercle bacilli. Studies on twelve year broth cultures maintained at incubator temperature. Am. Rev. Tuberc., 28, 856-874.
77. Corper, H.J., and Cohn, M.L. 1937 The thermolability of the tubercle bacillus. Am. Rev. Tuberc., 35, 663-677.
78. Corper, H.J., and Cohn, M.L. 1938 Some fundamental investigations on the resistance of tubercle bacilli. J. Bact., 35, 223-233.
79. Corper, H.J., and Gauss, H. 1923 The preservation of cultures of human and bovine tubercle bacilli. Am. Rev. Tuberc., 6, 1040.
80. Cram, E.B. 1924 The influence of low temperatures and of disinfectants on the eggs of Ascaris lumbricoides. J. Agr. Research, 27, 167-175.
81. Cramarossa, S. 1927 Vitality of some species in physiological salt solution and in twice distilled water. Pathologica, 19, 15-21.
82. Dack, G.M., and Williston, E.H. 1929 Effects of oxygen viability of young cultures of Clostridium botulinum. J. Infectious Diseases, 44, 27-32.
83. Das, N.B. 1949 Studies on the drying of rinderpest virus. Indian J. Vet. Sci. and Animal Husbandry, 19, 5-10.
84. Dautrebande, L., Highman, B., Alford, W.C., and Weaver, F.L. 1948 Studies on aerosols with an average mean micellary diameter under one-half micron. Study of the agglutination of liquid micellae. Arch. Internat. Pharmacodyn. et Ther., 76, 247-273.

85. Davis, F.L., Jr., and Williams, O.B. 1948 Studies on heat resistance. II. Comparison of resistance to heat of bacterial spores by selection. J. Bact., 56, 555-559.
86. Davis, F., Wyss, O., and Williams, O.B. 1948 Studies on heat resistance. II. Comparison of resistance to heat with resistance to disinfectants. J. Bact., 56, 561-567.
87. Deacon, W.E. 1932 An observation on the longevity of Serratia Marcescens. Science, 76, 274.
88. De Jong, D.A. 1922 Microorganisms and low temperatures. Arch. Neerland. Physiol., 7, 588-591.
89. Dharmendra, N.I. 1940 Viability of meningococcus in cool room (3½C to 8½C). Indian J. Med. Research, 28, 43-48.
90. Dick, G.W.A., Schwerdt, C.E., Huber, W., Sharpless, G.R., and Howe, H.A. 1951 Immunization of cotton rats with inactivated Lansing poliomyelitis. II. Inactivation by physical methods. Am. J. Hyg., 53:2, 131-138.
91. Dick, G.W.A., and Tayler, R.M. 1949 Bovine plasma albumin in buffered saline solution as a diluent for viruses. J. Immunol., Virus-Res. and Exp. Chemother., 62, 311-317.
92. Dieudonne, A. 1894 "Beiträge zur Beurtheilung der Einwirkung des Lichtes auf Bakterien" and "Ueber die Bedeutung des Wasserstoffsuperoxunds für die Bakterientötende Kraft des Lichtes. Arb. a.d. Kais. Gsndhtsamt., 9, 405-413, 537-540.
93. DoBell, C. 1927 Further observations and experiments on the cultivation of Entamoeba histolytica from cysts. Parasitology, 19, 288-313.
94. DoBell, C., and Laidlaw, P.P. 1926 On the cultivation of Entamoebae histolytica and some other entozoic amoebae. Parasitology, 18, 283.
95. Dognon, A. 1930 Resistance of bacteria to low air pressure; possibilities of biological study of slightly penetrating rays. Compt. rend. soc. biol., 103, 886-887.
96. Dold, H. 1947 Keim- Inhibition als Mittel der Mikrobienabwehr. Med. Klin., 42, 45-48.
97. Dopter, P. 1949 La conservation des cultures de levure par lyophilisation. Ann. Inst. Pasteur Lille, 2, 21-26.
98. Downes, A., Blunt, N.I. 1877 Researches on the effect of light upon bacteria and other organisms. Proc. Roy. Soc. London, 26, 488-500.
99. Downs, C.M., Coriell, L.L., Chapman, S.S., and Klauber, A. 1947 The cultivation of Bacterium tularense in embryonated eggs. J. Bact., 53, 89-100.
100. Dozier, C.C. 1924 Inhibitive influence of sugars and salt on viability, growth, and toxin production of B. botulinus. J. Infectious Diseases, 35, 134-155.
101. Dubos, R.J., and Fenner, F. 1950 Production of BCG vaccine in a liquid medium containing Tween 80 and a soluble fraction of heated human serum. I. Production and viability of the culture. J. Exp. Med., 91, 261-268.
102. Duclaux, N.I. 1885 Compt. rend acad. sci., Paris, 100, 119.
103. Duclaux, N.I. 1885 Compt. rend. acad. sci., Paris, 101, 395.
104. Duclaux, E. 1887 Sur les phenomenes generaux de la vie des microbes. Ann. Inst. Pasteur, Paris, 1, 145-152.
105. Duffy, C.E. 1946 pH stability of St. Louis encephalitis virus. Proc. Soc. Exp. Biol. Med., 63, 333-334.

106. Duhot, E., and Rachez, J. 1933 Comparative survival of bacilli: (coli) introduced experimentally into distilled water and into various mineral waters. Compt. rend. soc. biol., 112, 1432-1434.

107. Dunklin, E.W., and Puck, T.T. 1948 The lethal effect of relative humidity on air-borne bacteria. J. Exp. Med., 87, 87-100.

108. Ebersen, F. 1920 A note on the viability of meningococci on yeast agar medium. J. Bact., 5, 431.

109. Eichhorn, H. 1893 Beitrage z. Kenntniss des Einflussen vom Temperature- und Witterungsverhaltnissen auf die Tenacitat des tuberkulosen Sputums. Jena, B. Eugan.

110. Eigelsbach, H.T., Chambers, L.A., and Coriell, L.L. 1946 Electron microscopy of Bacterium tularense. J. Bact., 52, 179-185.

111. Eisler, M. 1909 Uber Wirkungen von Salzen auf Bakterien. Centr. Bakt., I. Abt., 51, 546-564.

112. Elberg, S.S., and Glassman, H.N. 1947 Viability of Brucella suis on storage in liquid culture. Am. J. Vet. Res., 8, 314.

113. Elford, W.J., Chu, C.M., Dawson, I.M., Dudgeon, J.A., Fulton, F., and Smiles, J. 1948 Physical properties of the viruses of Newcastle disease, fowl plague, and mumps. Brit. J. Expt. Path., 29, 590-599.

114. Elford, W.J., and Van den Ende, J. 1942 An investigation of the merits of ozone as as aerial disinfectant. J. Hyg., 42, 240-265.

115. Elford, W.J., and Van den Ende, M. 1944 Studies on viability and filterability of typhus rickettsiae. Brit. J. Exp. Path., 25, 213-220.

116. Elford, W.J., and Van den Ende, J. 1945 Disinfecting action of hypochlorous acid gas and sprayed solution of hypochlorite against bacterial aerosols. J. Hyg., 44, 1-14.

117. Elliker, P.R., and Frazier, W.C. 1938 Influence of time and temperature of incubation on heat resistance of Escherichia coli. J. Bact., 36, 83-98.

118. Elser, W.J., and Huntoon, F.M. 1909 Studies on meningitis. J. Med. Research, 20, 377-541.

119. Elser, W.J., Thomas, R.A., and Steffen, G.I. 1935 The desiccation of sera and other biological products (including microorganisms) in the frozen state with the preservation of the original qualities of products so treated. J. Immunol., 28, 433-473.

120. Eskey, C., and Hemphill, F. 1948 Relation of reported cases of typhus fever to location temperature, and precipitation. Pub. Health Repts., 63, 941-948.

121. Eskey, C.R., Prince, F.M., and Fuller, F.B. 1949 Transmission of Salmonella enteritidis by the rat fleas Xenopsylla cheopis and Nosopsyllus fasciatus. Pub. Health Repts., 64, 933-941.

122. Fasquelle, R., and Barbier, P. 1950 A few examples on preservation of bacteria and virus viability by desiccation under congelation. Compt. rend. soc. biol, Paris, 144, 23-24, 1618-1621.

123. Fasquelle, R., and Barbier, P. 1951 Drying under freezing and staphyloccil. Ann. Inst. Pasteur, Paris, 80:2, 217-220.

124. Feher, D. 1930 Untersuchungen über die Kohlenstoffernährung des Waldes. Verhandl. Internat. Kongr. Versuchsanst. (Stockholm), 1929, 546-556.
125. Feldman, W.H. 1932 Longevity of Mycobacterium tuberculosis of bovine origin. J. Am. Vet. Med. Assoc., 34, 223-229.
126. Feldman, W.H., and Olson, C.,Jr. 1935 Effects of certain environmental influences on the longevity of Brucella abortus suis. Am. J. Vet. Med. Assoc., 39, 153-161.
127. Finkelnburg, N.I. 1901 Arch. Hyg., 40, 321.
128. Finkelstein, H., Marx, W., Bridgers, W.H., and Beard, J.W. 1938 Rate of inactivation of Equine encephalomyelitis virus (eastern strain) relative to H ion concentration. Proc. Soc. Exp. Biol. Med., 39, 103-106.
129. Fischer, I. 1935 Prensa med. argent., 22, 340-343.
130. Flexner, S. 1907 Contributions to the biology of Diplococcus intracellularis. J. Exp. Med., 9, 105-141.
131. Flexner, S., and Amoss, H.L. 1917 Survival of the poliomyelitis virus for six years in glycerol. J. Exp. Med., 25, 539-544.
132. Flexner, S., Clark, P.F., and Amoss, H.L. 1914 A contribution to the pathology of epidemic poliomyelitis. J. Exp. Med., 19, 205-211.
133. Flexner, S., and Lewis, P.A. 1910 Experimental epidemic poliomyelitis in monkeys. J. Exp. Med., 12, 227-255.
134. Flexner, S., and Lewis, P.A. 1910 Epidemic poliomyelitis in monkeys. The activity of the virus. J. Am. Med. Assoc., 54, 45-46.
135. Florent, A. 1948 Methode de culture de Trichomonas bovis sur milieu solide. Compt. rend. soc. biol, 142, 405-406.
136. Flosdorf, E.W. 1949 Freeze-drying. New York: Reinhold Pub. Corp.
137. Flosdorf, E.W., and Mudd, S. 1935 Procedure and apparatus for preservation in "lyophile" form of serum and other biological substances. J. Immunol., 29, 389.
138. Flosdorf, E.W., and Mudd, S. 1938 An improved procedure and apparatus for preservation of sera, microorganisms and other substances- the Cryochem process. J. Immunol., 34, 469.
139. Flügge, C. 1905 Die in Hygienischen Institut der Königl. Universität Breslau wahrend der Genickstam-epidemic im Jahre 1905. Ausgefuhrten Untersuchungen. Klinisches Jahrubuch., 15, 353-372.
140. Foa, P., and Bordoni-Uffreduzzi, G. 1887 Sulla Eziologia Della Meningite Cerebrospinale Epidemica. Arch. Per. Le Sc. Med., 11, 385-421.
141. Foda, I.O., and Vaughn, R.H. 1950 Salt tolerance in the genus Aerobater. Food Technol., 4, 182-188.
142. Fram, H., Proctor, B.E., and Dunn, C.G. 1950 Effects of X-rays produced at 50 Kilovolts on different species of bacteria. J. Bact., 60, 263-267.
143. Francis, E. 1914 Laboratory studies on tetanus. Hyg. Lab. Bull., U.S. Pub. Health Service, No. 95.
144. Francis, E. 1932 Duration of viability and virulence of Bacillus pestis. U.S. Pub. Health Repts., 47, 1287-1294.

145. Francis, E. 1943 Twenty-year survival of virulent of virulent *Bacillus pestis* without transfer. U.S. Pub. Health Repts., 58, 1379.
146. Francis, E. 1949 Twenty-five year survival of a *Pasteurella pestis* culture without transfer. U.S. Pub. Health Repts., 64, 238-240.
147. Frank, M., and Hess, E. 1941 Studies on salt fish. IV. Survival of *Eberthella typhosa* and *Escherichia coli* on salt fish. J. Fish Res. Bd., Canada, 5, 249-252.
148. Frankland, P.F. 1894 Microorganisms in water.
149. Frobisher, M., Jr., Klein, G.C., and Cummings, M.M. 1949 Preservation of mycobacteria by desiccation in vacuo. Am. Rev. Tuberc., 60, 621-627.
150. Furushima, K. 1936 Untersuchungen uber die *Trichomonas vaginalis* der Japanerin. (III Mitteilung.). *Trichomonas vaginalis* und Milchsaure in der Scheide. Jap. J. Med. Sci., Gynecol., 1, 31.
151. Gabritschewsky, N.I., Wladimiroff, N.I., Krebling, N.I., and Gladin, N.I. (see Kasansky, M.W. (1899).
152. Gallo, P., and Calderon, T. 1948 El virus de la neumoenteritis de los terneros. Propiddades fisicas, patogenis y cultivo. Bol. Inst. Invest. Vet., 3, 528-537.
153. Galloway, I.A., and Elford, W.J. 1936 Purified foor-and-mouth disease virus. I. Studies on some of its physical properties. Brit. J. Exp. Path., 17, 187-203.
154. Germano, E. 1897 Die Uebertragung von Infektionskrankheiten durch die Luft. II. Mittheilung-Die Uebertragung der Diphtherie durch die Luft. Z. Hyg. Infektionskrankh., 25, 439-452.
155. Gibbons, N.E., and Fulton, C.O. 1943 Dried whole egg powder. VII. Effect of temperature and moisture on the bacterial content of liquid and dried egg. Canad. J. Res., 21, 332.
156. Gilcreas, F.W., and Roberts, H.V. 1950 Bacteriologic studies in disinfection of air in large rural central schools. I. Ultraviolet irradiation. Am. J. Pub. Health, 40, 808-812.
157. Gilles, E. 1935 Bacillus sterilization by means of high tension lamp which emits ultraviolet rays. Compt. rend. soc. biol., 118, 1440-1442.
158. Gladin, G.P. 1898 Die Legensfähigkeit der Pestbacillen unter verschieden physikalischen Bedingungen und der Einwirkung von Desinficientien. Centr. Bakt., 24, 588-592.
159. Glass, V., Goodhart, G.W., and Straker, E.A. 1946 An outbreak of food poisoning caused by *Salmonella typhimurium* conveyed by infected gelatin. Month. Bull. Med. Res. Council, 5, 90-94.
160. Glover, R.E. 1946 The effects of (a) freeze-drying and (b) low temperature on the viability of *Mycobacterium tuberculosis*. J. Path. Bact., 58, 111-114.
161. Gloyne, S.R. 1920 Viability of acid-fast bacilli. Tubercle, 2, 12.
162. Goetz, A., and Goetz, S.S. 1938 Vitrification and crystalization of protophyta at low temperatures. Proc. Am. Phil. Soc., 79, 361-388.

163. Goodlow, R.J., Braun, W., and Mika. L.A. 1951 Metabolite-resistance and virulence of smooth Brucella variants isolated after prolonged cultivation. Proc. Soc. Exp. Biol. Med., 76, 786-788.
164. Graham-Smith, G.S. 1930 Longevity of dry spores of anthrax bacilli. J. Hyg., 30, 213-215.
165. Grancher, N.I., and Richard, N.I. 1889 Action du sol sur les microbes pathogenes. Rev. Scient., Paris, 44, 365-369.
166. Greaves, R.I.N. 1944 Centrifugal vacuum freezing; its application to the drying of biological materials from the frozen state. Nature, London, 153, 485-487.
167. Grycz, E. 1949 The preservation of the fixed virus of rabies in glycerol in a dried state. Ann. Mariae Curie-Sklodowska Univ. Sect. D. Vet. Sci., 4, 49-58.
168. Gunderson, T. 1932 Germicidal effect of ultraviolet rays on virus of herpes; experimental studies. Arch. Ophth., 8, 519-529.
169. Gunderson, M.F., and Rose, K.D. 1948 Survival of bacteria in precooked, fresh frozen food. Food Research, 13, 254-263.
170. Haagen, E. 1939 Weitere Erfahrungen über die Züchtung und Konservierung des Vakzinevirus. Z. Bakt. I (Orig.), 143, 283-291.
171. Hailer, E., and Heicken, K. 1948 Untersuchungen zur Bekampfung des gewerblichen Milzbrandsporen bei 20, 12 und 4. Z. Hyg. Infektionskrankh., 128, 87-108.
172. Haines, R.B. 1934 The freezing and death of bacteria. Rept. Food Invest. Bd., Great Britain. 47-48.
173. Haines, R.B. 1934 The minimum temperatures of growth of some bacteria. J. Hyg., 34, 277-281.
174. Haines, R.B. 1937 The effect of freezing on bacteria. Proc. Roy. Soc., London, 124, 451-463.
175. Hall, I.W., and Fraser, A.D. 1921 The pH range for staphylococci. Brit. J. Exper. Path., 2, 242.
176. Hammer, B.W. 1911 A note on the vacuum desiccation of bacteria. J. Med. Res., 24, 527.
177. Hammon, W. McD., and Izumi, E.M. 1941 Armstrong mouse adapted poliomyelitis virus: effect of pH of inoculum, and of "enteric organism filtrate". Proc. Soc. Exp. Biol. Med., 48, 579-583.
178. Hammon, E.McD., Rees, D.M., Casals, J., and Meiklejohn, G. 1949 Experimental transmission of Japanese B encephalitis virus by Culex tritaeniorhynchus and Culex pipiens var. pallens, suspected natural vectors. Am. J. Hyg., 50, 46-50.
179. Hampp, E.G. 1947 Preservation of Borrelia vincentii and cultured strains of Treponema pallidum by the lyophile process. J. Am. Dent. Assoc., 34, 317-320.
180. Hampp, E.G. 1951 Preservation of viability and pathogenicity of the Nichols rabbit strain of Treponema pallidum by freeze-drying. Pub. Health Repts., 66, 501-506.
181. Hankin, E. 1896 L'action bactericide des eaux de la Jumna et du Gange. Ann. Inst. Pasteur, 10, 511-523.

182. Harris, D. 1948 On the purification of rabies vaccine. Science, 108, 158.
183. Harris, J.O., and Patty, R.E. 1949 Conductivity studies of bacterial suspensions. J. Bact., 57, 67-71.
184. Harris, M.M., and Lange, L.B. 1933 A note on the preservation of acid-fast bacteria in vacuo. J. Lab. Clin. Med., 18, 1066.
185. Hartsell, S.E. 1951 The growth initiation of bacteria in defrosted eggs. Food Res., 16, 97-106.
186. Hawkins, J.A. 1929 Effect of drying on certain of virus group. Proc. Soc. Exp. Biol. Med., 26, 479-480.
187. Hegarty, C.P., and Weeks, O.B. 1940 Sensitivity of Escherichia coli to cold shock during the logarithmic growth phase. J. Bact., 39, 475-484.
188. Heiberg, B. 1932 Resistance of young and old bacteria to heat. Z. Hyg. Infektionsrankh., 114, 425-428.
189. Heller, G. 1941 Quantitative study of environmental factors involved in survival and death of bacteria in desiccated state. J. Bact., 41, 109-126.
190. Hess, N.I. 1934 Atlantic Fisheries, Exp. Sta., J. Biol. Bd., Canada, 1, 95-108.
191. Hesse, W. 1889 Unsere Nahrungsmittel als Nährböden für Typhus und Cholera. Z. Hyg., 5, 527-546.
192. Hesseltine, C.W. 1947 Viability of some mold cultures. Mycologia, 39, 126-128.
193. Hilliard, C.M., and Davis, M.A. 1918 The germicidal action of freezing temperatures by bacteria. J. Bact., 3, 423-431.
194. Hills, S. 1946 Isolation of tetanus bacilli from infected talc. New Zealand Med. J., 45, 419-423.
195. Hindle, E. 1934 Viability of spirochetes dried in vacuo. Nature, London, 133, 381-382.
196. Hinds, M.E. 1921 Iowa Eng. Exp. Sta. Bull.
197. Hirsch, J., and Müller, A.W. 1933 Oxygen consumption in propagation of bacteria. Klin. Wochschr., 12, 231.
198. Hite, K.E., and Dack, G.M. 1938 Survival of Clostridium sporogenes, Bacillus subtilis, and Staphylococcus albus on surgical (catgut) ligatures. Surgery, 4, 548-551.
199. Hoder, F. 1928 Bacteria on raw fruit. Deutsche Med. Wochschr., 54, 1806-1808.
200. Hoffstadt, R.E., and Tripi, H.B. 1946 A study of the survival of certain strains of viruses after lyophilization and prolonged storage. J. Infectious Diseases, 78, 183-189.
201. Hollaender, A., Stapleton, G.E., and Martin, F.L. 1951 X-ray sensitivity of E. coli as modified by oxygen tension. Nature, London, 167, 103-104.
202. Holland, D.F. 1922 The effect of potassium and magnesium chlorides on the viability and electrical resistance of Bacterium coli communis. Diss., Yale Univ. Lib.
203. Homma, N.I., and Koida, K. 1927 Ueber die Resistenz der Tuberkelbazillen gegen Kaelte. J. Oriental Med., 7, 56-58.
204. Hornibrook, J.W. 1951 Dried smallpox vaccine. Pub. Health Repts., 66, 38-43.

205. Horsfall, F.L. 1940 Present status of knowledge concerning influenza. Am. J. Pub. Health, 30, 944.
206. Horwood, M.P., Horton, J.P., and Minch, V.A. 1950 Some effects of ultrasonic vibrations on *Escherichia coli*. Bact. Proc.
207. Houston, A.C. 1912 Significance of *B. coli* in water. Brit. Med. J., No. 2699, 901.
208. Howitt, B. 1930 Poliomyelitis virus. Results of treating with certain chemicals and with heat. Proc. Soc. Exp. Biol. Med., 28, 158.
209. Huddleson, I.F. 1949 A satisfactory medium for the isolation, cultivation, and maintenance of viability of *Vibrio fetus* (bovine). J. Bact., 56, 508.
210. Hurlbut, G.S. 1950 The recovery of poliomyelitis virus after parenteral introduction into cockroaches and houseflies. J. Infectious Diseases, 86, 103-104.
211. Ibanez, R. 1949 Preservacion de micro-organismos. Rev. Sanidad E Hig. Publ. (Madrid), 23, 395-409.
212. Imshenetskii, A.A. 1946 Ecology of pigmented microorganisms. I. Protective influence of carotenoids. Mikrobiologiya, 15, 422-427.
213. Irwell, W. 1894 The influence of heat and cold upon microbes. New Sc. Rev., Phila.
214. Isaacs, M.L. 1930 Factors which influence tests of bacterial survival. II. The effect of the pH of the survival test culture on results obtained with a saprophytic tubercle bacillus. J. Bact., 20, 175-181.
215. Isaacs, M.L. 1930 Factors which influence tests of bacterial survival. I. The effect of varying periods of incubation of the survival test culture. J. Bact., 20, 161-174.
216. Jacotot, H. 1926 Vitality of Pasteurella of hemorrhagic septicemia of animals. Compt. rend. soc. biol., 95, 1020-1021.
217. Jackson, E., and Smadel, J. 1951 Immunization against scrub typhus. II. Preparations of lyophilized living vaccine. Am. J. Hyg., 53, 326-331.
218. Jahnel, F. 1938 "Ueber das Ueberleben von Syphilis spirochäten bei Tiefster Temperatur (-271.5C, 1.7C vom absoluten Nullpunkt enfernt)". Klin. Wochschr., 17, 836-838.
219. James, L.H. 1933 Effects of freezing on the spores and toxin of *Clostridium botulinum*. J. Infectious Diseases, 52, 236-241.
220. Jettmar, H.M.v. 1927 Studien über die Vitalität der Scharlachstreptokokken. Z. Hyg. Infektionskrankh., 107, 265-287.
221. Jolles, M. 1895 Weitere Untersuchungen über die Desinfections- fähigkeit von Seifenlösungen. Z. Hyg. Infektionskrankh., 19, 130-138.
222. Jones, E.R. 1942 Isolation from industrial material of anthrax bacilli, with special reference to resistance of spores to heat. J. Path. Bact., 54, 307-314.
223. Jones, M. 1945 Adaption of influenza virus to heat. Proc. Soc. Exp. Biol. Med., 58, 315-319.
224. Jordan, R.X., and Jacobs, S.E. 1948 Studies in the dynamics of disinfection. XII. The effect of variation in pH on the rate of disinfection at 51C of standard cultures of *Bacterium coli*. J. Hyg., 46, 136-147.

225. Jungeblut, C.W. 1935 Epidemic meningitis. Agent of disease and host resistance. Frederick P. Gay, Springfield.
226. Jungeblut, C.W. 1937 Effect of ultraviolet rays on poliomyelitis virus in vitro. Proc. Soc. Exp. Biol. Med., 37, 160-162.
227. Kadisch, E. 1931 Beiträge zur Wirkung der Kalte auf pathogene Fadenpilze, Hefen, und Bakterien. Ausdehnung dieser. Versuche bis in die Nähe des absoluten Nullpunktes (bis -272C). Med. Klin., 27, 1074-1078, 1109-1112.
228. Kaess, G., and Schwartz, W. 1935 Growth of mold fungi in high relative humidity. Arch. Mikrobiol., 6, 208-214.
229. Karaffa-Korbutt, K.v. 1912 Zur Frage des Einflusses des Kochsalzes auf die Lebenstätigkeit der Mikroorganismen. Z. Hyg. Infektionskrankh., 71, 161.
230. Karcher, H. 1931 Planta, 14, 515-516.
231. Karwacki, L. 1928 Effect of time on vitality of bacterial cultures. Compt. rend. soc. biol., 99, 1150-1152.
232. Kasansky, M.W. 1895 Ueber den Einflub der Kälte auf die Cholerabakterien von Koch und ähnliche Vibrionen von Finkler-Prior, Miller, Deneke und die Vibrionen Metschnikoff. Centr. Bakt., 17, 185-187.
233. Kasansky, M.W. 1899 Die Einwirkung der Winterkälte auf die Pest- und Diphtherie bacillen. Centr. Bakt. 1. Abt., 25, 122-124.
234. Kayser, N.I. 1889 Ann. Inst. Pasteur, 3, 513-525.
235. Keith, S.C. 1913 Factors influencing the survival of bacteria at temperatures in the vicinity of the freezing point of water. Science, 37, 877.
236. King, A.G. 1930 Viability of the organism of Rocky Mountain spotted fever when frozen. J. Infectious Diseases, 46, 279-284.
237. King, H.K., and Alexander, H. 1948 J. Gen. Microbiol., 2, 315.
238. Kirstein, F. 1902 Ueber die Dauer der Lebensfähigkeit von Krankheitserregern in der Form feinster Tröpchen und Stäubchen. Z. Hyg. Infektionskrankh., 39, 93-170.
239. Kiser, J.S., and Beckwith, T.D. 1942 Effect of fast-freezing upon bacterial flora of makerel. Food Research, 7, 255-259.
240. Kissmeyer, A. 1928 Length of life of Spirochaeta pallida. Dermatol. Z., 52, 115.
241. Kister, J. 1928 Verbreitung von Typhus durch Abfallstoffe. Arch. Hyg., 100, 1-4.
242. Kitasato, S. 1889 Die Widerstandfahigkeit der Cholerabacterien gegen das Eintrocknen und gegen Hitze. Z. Hyg. Infektionskrankh., 5, 134-140.
243. Kitasato, S. 1894 The bacillus of bubonic plague. Lancet, 2, 428-430.
244. Kling, C., and Pettersson, A. 1914 Keimträger der Kinderlähmung. Deut. Med. Wochnschr., 40, 320.
245. Kling, C., Levaditi, C., and Lepine, P. 1929 Bull. Acad. Med., Paris, 102, 158.
246. Koch, R. 1882 Die Aetiologie der Tuberculose. Berlin Klin. Wochschr., 229.
247. Konrich, N.I. 1935 Vorkommen Resistenz hochresistenter Erdsporen mit besonderer Berucksichtung der Instrumenten sterilisation. Deut. Z. Chir., 245, 141-148.

248. Koser, S.A., and McClelland, J.R. 1917 Fate of bacterial spores in animal body. J. Med. Research, 37, 259.
249. Kosikowsky, F.V., and Dahlberg, A.C. 1948 The growth and survival of Streptococcus fecalis in pasteurized milk American Cheddar cheese. J. Dairy Sci., 31, 285-292.
250. Krantz, W. 1923 Action of low temperatures on cultures of spirochetes. München. Med. Wochschr., 70, 628-629.
251. Kruse, W. 1895 Ueber die Hygienische Bedeutung des Lichtes. Z. Hyg., 19, 313-333.
252. Kyes, P., and Potter, T.S. 1939 The resistance of avian tubercle bacilli to low temperatures with especial reference to multiple changes in temperature. J. Infectious Diseases, 64, 123.
253. Lacy, G.R., and Haythorn, S.R. 1921 Viability of Spirocheta pallida in excised tissue and autopsy material. Am. J. Syphilis, 5, 401.
254. Lal, Nand 1921 Viability of bacterial cultures. Indian J. Med. Research, 8, 728-730.
255. Lal, Nand 1923 Effect of direct sunlight on sealed cultures of organisms. Indian, J. Med. Research, 11, 445-447.
256. Lal, Nand 1925 Viability of bacterial cultures. Indian J. Med. Research, 13, 189-190.
257. Lal, R.B., and Yacob, M. 1926 Relative suitability of certain foodstuffs as media for cultivation of V. cholerae with special reference to their relative role in dissemination of cholera. Indian J. Med. Research, 14, 245-255.
258. Lal Kalra, S. 1948 Survival of cultures in dry state. Indian Med. Gaz., 83, 28-29.
259. Landsteiner, K., and Levaditi, C. 1910 Compt. rend. soc. biol., 67, 787.
260. Landsteiner, K., Levaditi, C., and Pastia, M. 1911 Experimental studies of acute poliomyelitis. Ann. Inst. Pasteur. 25, 805.
261. Landsteiner, K., and Mucha, J. 1906 Zur Technik der Spirochaetenuntersuchung. Wien. Klin. Wochschr., 19, 1349.
262. Larson, W.P., and Montank, I.A. 1922-23 The effect of wetting on the pathogenicity and viability of the tubercle bacillus. Proc. Soc. Exper. Biol. Med., N.Y., 20, 229-232.
263. Laser, H. 1891 Über das Verhalten von Typhusbacillen, Cholerabacterien und Tuberkelbacillen in der Butter. Z. Hyg., 10, 513-520.
264. Latarjet, R. 1951 Moderate germicidal action of fluorescent lights. Bull. acad. nat. med., Paris, 135:7-8, 20-27.
265. Launder, W.H. 1932 Longevity of anthrax spores. Lancet, 223, 707.
266. Lawson, R.B., and Melnick, J.L. 1947 Heat inactivation of murine poliomyelitis viruses. J. Infectious Diseases, 80, 201-208.
267. Ledingham, J.C.G. 1911 On the survival of specific microorganisms in pupae and imagines of Musca domestica raised from experimentally infected larvae: experiments with B. typhosus. J. Hyg., Cambridge, 11, 333-340.

268. Lee, R.E., and Gilbert, C.A. 1918 Application of the mass law to the process of disinfection. J. Physiol. Chem., 22, 348, 295, 353, 371.
269. Lehmann, W. 1949 Konservierung von Vaccine virus-Kulturen. Arch. ges. Virusforsch., 4, 175-185.
270. Leiner, C., and Wiesner, R. von 1910 Wien. Klin. Wochnsehr., 23, 91.
271. Lenskaja, G.N., Egoroff, A.N. Et Al 1931 Lebenserhaltung des B. pestis bei vieljährigen Aufbewahrung auf Nährboden. Vestnik. Mikr. Epidemiol., 10, 149-158.
272. Lepine, P., Sautter, V., and Kreis, B. 1937 Siege de la virulence dans la chorio-meningite lymphocutaire; caracteres du virus. Compt. rend. soc. biol., 124, 422.
273. Levaditi, C. 1913 Compt. rend. soc. biol., 74, 1179, 75, 202.
274. Levine, M. 1921 Iowa Eng. Exper. Sta. Bull., 62, 66.
275. Lindner, J. 1915 Jahrb. F. Wiss. Bot., 55, 1-52.
276. Ling, A.R., and Nanji, D.R. 1921 Longevity of certain species of yeast. Proc. Roy. Soc., London, 92, 355-357.
277. Lion, K.S., and Gould, B.S. 1949 Effect of high frequency electric fields on some microorganisms. Am. Brewer, 82, 21-24.
278. Lionetti, G. 1937 Question whether gonococci can be conserved in state of latent viability by method of desiccation. Gazz. Internaz. Med.-Chir., 47, 223.
279. Lipman, C.B. 1926 Concentration of sea-water as affecting its bacterial population. J. Bact., 12, 311-313.
280. Loewenberg, N.I. 1894 Le microbe de l'ozene. Ann. Inst. Pasteur, 8, 292.
281. Loewenthal, N.I. 1906 (see McCulloch, E.C., 1945).
282. Lofgren, R., and Soule, M. 1945 The effect of low temperature on the spirochetes of relapsing fever. II. The structure and motility of Spirochaeta novyi. J. Bact., 50, 313-321.
283. Lord, F.T., and Nye, R.N. 1922 Acid death point of pneumococcus. J. Exp. Med., 35, 685-687.
284. Lorentz, F.H. 1924 Die Hinfälligkeit der Gonokokken. München. Med. Wochschr., 71, 173.
285. Louros, N.C. 1923 Zur Resistenprüfung der Streptokokken. Klin. Wochschr., 2, 1929-1930.
286. Lund, A.J., and Halvorson, H.O. The effects of low temperatures on enzymes and microorganisms. Hormel Institute publication No. 62.
287. Luria, S.E. 1946 Spontaneous bacterial mutations to resistance to anti-bacterial agents. Cold Spring Harbor Symp. Quant. Biol., 11, 130-138.
288. Luyet, B.J., and Gehenio, P.M. 1938 The lower limit of vital temperatures. A review. Biodynamica, No. 33, 341.
289. Luyet, B.J., Gehenio, P.M. 1940 Life and death at low temperatures. Biodynamica, Monograph No. 1.
290. Macchiavello, A. 1937 Survival and virulence of frozen and dried Mexican and European typhus viruses. Rev. Chilena de Hig. y Med. Prev., 1, 63-68.
291. Mayer, E., and Dworski, M. 1924 Studies with ultraviolet light. III. The bactericidal action of mercury-quartz-vapor light irradiation. Am. Rev. Tuberc., 10, 166-169.

292. McCollum, W.H., and Doll, E.R. 1951 A medium for maintaining the viability of Shigella equuli cultures. Cornell Vet., 41, 11-12.
293. MacConkey, A. 1905 Lactose-fermenting bacteria in faeces. J. Hyg., 5, 333.
294. McCormack, G. 1950 "Pink yeast" isolated from oysters grows at temperatures below freezing. Commercial Fish Rev., 12, 28.
295. McCrae, A. 1923 Longevity in spores of Aspergillus oryzae and Rhizopus nigricans. Science, 58, 426.
296. McFarlane, V.H. 1940 Behavior of microorganisms at subfreezing temperatures. I. Freezing redistribution studies. Food, Research, 5, 43-57.
297. MacFayden, A. (see Bolley and Field 1898).
298. MacFayden, A. 1899-1900 On the influence of the temperature of liquid air on bacteria. Proc. Roy. Soc., London, 66, 180.
299. MacFayden, A. 1900 On the influence of the temperature of liquid air on bacteria. Lancet, 849.
300. MacFayden, A. 1900 Proc. Roy. Soc., 66, 180,339.
301. MacFayden, A., and Rowland, S. 1900 Further note on the influence of the temperature of liquid air on bacteria. Proc. Roy. Soc., London, 66, 339-340.
302. MacFayden, A., and Rowland, S. 1900 Influence of the temperature of liquid hydrogen on bacteria. Proc. Roy. Soc., London, 66, 488-489.
303. MacFayden, A., and Rowland, S. 1902 On the influence of the prolonged action of the temperature of liquid air on microorganisms, and on the effect of mechanical trituration at the temperatures of liquid air on photogenic bacteria. Proc. Roy. Soc., London, 71, 76-77.
304. McKinley, E.B., Fisher, R., and Holden, M. 1926 Action of ultraviolet light upon bacteriophage and filterable viruses. Proc. Soc. Exp. Biol. Med., 23, 408-412.
305. McKinney, H.H. 1947 Stability of labile viruses in desiccated tissue. Phytopath., 37, 139-142.
306. McLeod, C., and Arnold, R.C. 1949 Preservation and inoculation studies on Treponema pallidum. J. Venereal Disease Inform., 30, 104-107.
307. McLimans, W.F. 1947 The inactivation of equine encephalitis virus by mechanical agitation. J. Immunol. Virus Research and Exp. Chemother., 56, 385-391.
308. McNaught, J.G. 1910 On the resistance of B. coli to sunlight and drying. Centr. Bakt. I Abt., 53, 326-334.
309. Marchoux, E., and Prudhomme, R. 1938 Hansen's bacillus dies in less than thirty minutes at 60C and by desiccation. Bull. Acad. Med., Paris, 120, 174-176.
310. Marcuse, K. 1949 Bakteriophagenkonservierung über lange Zeit. Z. Bakt. I. Abt. Orig., 154, 254-256.
311. Medical Research Council 1947 The bacteriology of spray-dried eggs with particular reference to food poisoning. Great Britain privy Council (Med. Res. Counc. Spec. Rept. Serv.), 260, 6-66.
312. Meissner, R. Ten-year experiment on the longevity of wine yeasts in pure cultures on 10 per cent cane sugar solution. Z. Garungs Physiol., 1, 106-113.

313. Meissner, R. 1911 J. Inst. Brewing, 17, 621.
314. Mejlbo, E.G. 1941 Method in the preservation of preparations of *Lactobacillus acidophilus*. U.S. Patent 2,518,355.
315. Meleney, F.L., and Zau, Zung-Dau 1924 Viability of hemolytic streptococci in certain solutions with a gelatin. J. Exp. Med., 39, 811-825.
316. Melnick, J.L. 1946 Storage of mouse adapted strains of poliomyelitis and of Japanese B encephalitis virus at subfreezing temperatures. J. Infectious Diseases, 79, 27-32.
317. Melsens, M. 1870 Note on the vitality of yeast in beer. Compt. rend. acad. sci., 70, 629-634.
318. Merlini, D. 1938 Survivance ultra-trentenaire d'une germe asporigene. Internaz Microbiol. Boll. Sez. Ital., 10, 215-217.
319. Miller, R.P. 1946 Viability of dried *Bacterium tularensis*. U.S. Pub. Health Repts., 61, 1084-1085.
320. Miller, C.P., and Schad, D. 1944 Germicidal action of daylight on meningococci in the dried state. J. Bact., 47, 79-84.
321. Minck, F. 1896 Zur Frage uber die Einwirkung der Röntgen'schen Strahlen auf Bacterien und ihre eventuelle therapeutische Verwendbarkeit. Munch. Med. Wochnschr., 43, 101-102.
322. Miyao, I. 1930 Viability of *Spirochaeta pallida*. Philippine J. Sci., 42, 199-201.
323. Mohr, H. 1937 Z. geburtsh gynäk., 115, 115-129.
324. Moriya, G. 1909 Ueber die Umwandlungshypothese und Lebensdauer des Tuberkelbacillus. Centr. Bakt. I Abt. Orig., 51, 480-493.
325. Morse, M.L. 1950 Resistance to ultraviolet radiation in *Escherichia coli*, strains B and B/r. Bact. Proc., 1950, 135.
326. Morton, H.E., and Pulaski, E.J. 1938 The preservation of bacterial cultures. J. Bact., 35, 163-183.
327. Murray, C., McNutt, S.H., and Purwin, P. 1932 The effect of pasteurization upon *Brucella melitensis* var. suis. J. Am. Vet. Med. Assoc., 80, 336-342.
328. Murray, E.G.D. 1929 The meningococcus. Med. Res. Counc. Spec. Rep. Ser., 124.
329. Naylor, H.B., and Smith, P.A. 1946 Factors affecting the viability of Serratia marcescens during dehydration and storage. J. Bact., 52, 565-573.
330. Neisser, N.I. 1911 Pathologie und Therapie der Syphilis, Berlin. Arb. A.D.K. Gesundh., 37.
331. Nelson, R.A., Jr. 1948 Factors affecting survival of *Spirochaeta pallida* in vitro. Am. J. Hyg., 48, 120-132.
332. Nelson, R., and Steinman, H. 1948 Factors affecting the survival of *Treponema pallidum* in vitro. Proc. Soc. Exp. Biol. Med., 68, 588.
333. Nigg, C. 1935 On the preservation of typhus fever rickettsiae in cultures. J. Exp. Med., 61, 17.
334. Nobrega, P., and Bueno, R.C. 1950 Influencia da temperatura na conservacao da viabilidade e virulencia da Pasteurella avicida. Bol. Soc. Paulista Med. Vet. Sao Paulo, 8, 189-194.

335. Noguchi, H. 1918 Further studies on the properties of pure vaccine virus cultivated in vivo. J. Exp. Med., 27, 425-442.
336. Novel, E., and Reh, T. 1947 The longevity of the spores of B. anthracis and the conservation of its pathogenic and antigenic properties. Schweiz. Z. Path. u. Bakt., 10, 180-192.
337. Ohba, N.I. 1923 (see Faust, E.C. 1924).
338. Olesiuk, O.M. 1951 Influence of environmental factors on viability of Newcastle disease virus. Am. J. Vet. Res., 12:43, 152-155.
339. Olitsky, P.K., Jordi Casals, Walker, D.L., Ginsberg, H.S., and Horsfall, F.L. 1949 Preservation of viruses in a mechanical refrigerator at -25C. J. Lab. Clin. Med., 34, 1023-1026.
340. Omeliansky, V. 1926 La resistance des cultures d'Azotobacter chroococcum a la desiccation. Compt. rend. acad. sci., 183, 707-708.
341. Orskov, S.L. 1925 Versuche über Thermoresistenz, Thermoresistenz in verschiedenen Nährböden, Thermoresistenz von Culturen verschiedenen Alters. Z. Hyg. Infektionskrankh., 105, 317-341.
342. Oshii, O. 1920 The fate of bacteria of the colon-typhoid group on carbohydrate media. J. Bact., 5, 437-440.
343. Osler, W. 1901 Practice of Medicine (4th Ed.).
344. Otten, L. 1930 Die Trockenkonservierung von pathogenen Bakterien. Centr. Bakt. I Orig., 116, 199-210.
345. Ottosen, H.E. 1945 Studies on Corynebacterium Magnusson-Holth with special references to its serological aspects. Skand. Vet. Tidskr., 35, 635-654.
346. Pabst, A.M. 1935 Use of below freezing temperatures for maintenance of meningococcus cultures. U.S. Pub. Health Repts., 50, 732.
347. Packchanian, A. 1943 On the viability of various species of Trypanosoma and Leishmania cultures. J. Parasitol., 29, 275-277.
348. Panisset, L., Verge, J., and Carneiro, V. 1925 Action of saline and distilled water on microbes. Ann. Inst. Pasteur, 39, 80-85.
349. Park, W.H. 1901 Duration of life of typhoid bacilli, derived from twenty different sources, in ice; effect of intense cold on bacteria. Science, 13, 323.
350. Park, N.I., Williams, N.I., and Krumwiede 1924 Pathogenic microorganisms. New York (8th Ed.).
351. Parker, E.R., Dunham, W.B., and MacNeal, W.J. 1944 Resistance of the Melbourne strain of influenza virus to desiccation. J. Lab. Clin. Med., 29, 37-42.
352. Paschen, E. 1908 Arch. F. Kinderheilk., 47, 168.
353. Pasteur, L. 1876 Etude sur le Biere, 150-155.
354. Patella, V. 1888 Sulla pneumonite cruposa. Atti Della reale accad. med. di Roma, 4, 447-474.
355. Paul, T. 1909 Der chemische Reaktionsverlauf beim absterben trockener Bakterien bei niederen Temperaturen. Biochem. Z., 18, 1-15.
356. Paul, T., and Prall, F. 1907 Die Wertbestimmung von Desinfektionsmitteln mit Staphylokokken, die bei der Temperatur der flüssigen Luft aufbewahrt wurden. Arb. Kaiserl. Gesundh., 26, 73-129.

357. Payzin, S. 1947 Survival of rickettsia. Trop. Diseases Bull., 44, 703.
358. Pelzer, L.R., Steffen, G.I., and Klein, S. 1949 Simple and efficient transport method for gonorrheal specimens. U.S. Pub. Health Repts., 64, 599-603.
359. Pergola, M. 1950 Sopravvivenza ultratrentennale di batteri aerobi asporigeni. Rend. Ist Superiore Sanita, Rome, 13, 571-579.
360. Perry, W.L. 1948 The cultivation of Treponema pallidum in tissue culture. J. Path. Bact., 60, 339-342.
361. Pesch, K.L., and Sauerborn, E. 1929 Chemical and bacteriological sewage investigations. Gesundh. Ing., 52, 856.
362. Petri, N.I. (see Webb, G.B. 1921).
362. Phelps, E.B., and Buchbinder, L. 1939 The survival rates and resultant pathogenic properties of B hemolytic streptococcus in experimental room. Symposium on Airborne Infections, Third Internat. Congr. Microbiol. Rept. Proc., N.Y., 266-273.
363. Philibert, A., and Risler, J. 1926 Effects of neon light on bacteria. Compt. rend. acad. sci., 183, 1137-1139.
364. Pictet, R., and Yung, E. 1884 Compt. rend. acad. sci., 98, 747-749.
365. Pieper, E., and Retzlaff, E. 1930 "Lebensdauer und Formerhaltung der Gonokokken in Flüssigkeiten". Zentr. Bakt., Abt. 1, 118, 47-50.
366. Polding, J.B. 1947 Brucellosis in India. Indian J. Vet. Sci. and Animal Husbandry, 17, 147-155.
367. Porter, J.R. 1947 Bacterial chemistry and physiology. John Wiley and Sons, N.Y.
368. Potter, T.S. 1935 The survival of tubercle bacilli subjected to a vacuum of high order. J. Infectious Diseases, 57, 149-159.
369. Potter, T.S. 1937 Survival of oxygen and water deprival by tubercle bacilli. J. Infectious Diseases, 60, 88-93.
370. Potter, T.S. 1939 Survival and death of bacilli subjected to oxygen restriction. J. Infectious Diseases, 64, 261-268.
371. Potter, T.S. 1942 The death of tubercle bacilli subjected to oxygen deprivation in the presence of moisture and of warmth. J. Infectious Diseases, 71, 220-224.
372. Prier, J.E., and Alberts, J.O. 1950 Studies on Newcastle disease. VII. Viability of live embryo Newcastle disease virus in buffered glycerol. Cornell Vet., 40, 300-303.
373. Proom, H., and Hemmons, L.M. 1949 The drying and preservation of bacterial cultures. J. Gen. Microbiol., 3, 7-18.
374. Prudhomme, N.I. 1935 Influence of pH on the disruption of tubercle bacilli. Compt. rend. soc. biol., Paris, 118, 983-986.
375. Pugnani, E. 1929 Observations et recherches sur la resistance de la mycobacterie de la tuberculose de type humain. Boll. Soc. Internez. Microbiol. Ital., 1, 127.
376. Pyl, G. 1938 Behringer Mitt., 9, 6.

377. Quastel, J.H., and Wooldridge, W.R. 1927 Effects of chemical and physical changes in environment on resting bacteria. Biochem. J., 21, 148-168.
378. Rahn, Otto 1932 Physiology of bacteria. P. Blakiston's Son and Co., Inc., Philadelphia.
379. Rahn, Otto 1945 Injury and death of bacteria by chemical agents. Reprinted from Biodynamica: Monographs 86, 1943, and 96, 1945.
380. Rake, G. 1935 Viability and virulence of frozen and dried cultures of meningococcus. Proc. Soc. Exp. Biol. Med., 32, 975-977.
381. Raketen, M.L. 1947 Observations on the stability of certain bacteriophages. J. Bact., 53, 127.
382. Ransom, S.E., and Huebner, R.J. 1951 Studies on the resistance of Coxiella burneti to physical and chemical agents. Am. J. Hyg., 53, 110.
383. Ransome, A., and Foulerton, A. 1901 On the influence of ozone on the vitality of some pathogenic and other bacteria. Lancet, London, I, 607-609.
384. Rapschewski, N.I. 1901 Arch. Hyg., 40, 320.
385. Ravitch, M.M., and Chambers, J.W. 1942 Spirochetal survival in frozen plasma. Bull. Johns Hopkins Hosp., 71, 299-303.
386. Raynor, A.G. 1943 A simple method for the preservation of cultures and sera by drying. J. Path. Bact., 55, 373-375.
387. Read, W.D.B., Singh, G., Seal, S.C., and Bose, S. 1939 Growth and survival of cholera vibrio, especially in water. Indian J. Med. Research, 27, 1-40.
388. Regnier, J. Lambin, S., and Jund, Y. 1938 Variations of resistance of B. coli in relation to age of culture. Compt. rend. soc. biol., 128, 744-746.
389. Reitano. U. 1939 Vitality of Spirocheta icterhaemorrhahagiae in culture. Pathologica, 31, 283-286.
390. Remlinger, P., and Bailly, J. 1934 Action of freezing on rabies virus. Compt. rend. soc. biol, 116, 407-409.
391. Remy, N.I. 1900 Ann. inst. Pasteur, 12, 63.
392. Renk, N.I. 1893 Ueber das Verhalten der Cholerabacillen in Eise. Centr. Bakt., Abt., 14, 183.
393. Repaci, G. 1910 Contribution a la connaissance de la vitalite des microbes anaerobies. Compt. rend. soc. biol., 68, 524.
394. Res. Comm. Min. Agric. Fish, London. Second Prog. Rept. Foot and Mouth Disease. 1927.
395. The Commission on Acute Respiratory Diseases. 1946 A laboratory outbreak of Q fever caused by the Balkan grippe strain of Rickettsia burneti. Am. J. Hyg., 44, 123-157.
396. Rhoads, C.P. 1929 Survival of the virus of poliomyelitis for eight years in glycol. J. Exp. Med., 49, 701-704.
397. Rhodes, M. 1950 Viability of dried bacterial cultures. J. Gen. Microbiol, 4, 450-456.
398. Rice, F.A.H., and Nelson, R.A. 1951 Isolation from beef serum of a survival factor for Treponema pallidum. J. Biol. Chem., 19, 35-41.
399. Rivers, T.M. 1927 Effect of repeated freezing (-185C) and thawing on colon bacilli, virus III, vaccin virus, herpes virus, bacteriophage, complement, and trypsin. J. Exp. Med., 45, 11-21.

400. Rivers, T.M. 1939 Viruses and virus diseases. Stanford University, California: Stanford Univ. Press.
401. Rivers, T.M. 1948 Viral and rickettsial infections of man. J.B. Lippincott, Philadelphia.
402. Rivers, T.M., and Gates, J. 1928 The effect of monochromatic ultraviolet light upon vaccine virus. J. Exp. Med., 47, 45-49.
403. Rivers, T.M., Smadel, J.E., and Chambers, L.A. 1937 Effect of intense sonic vibrations on elementary bodies of Vaccinia. J. Exp. Med., 65, 677-685.
404. Robertson, O.H., and Lester, W., Jr. 1951 The lethal effect of triethylene glycol vapor on dried air-borne bacteria. Am. J. Hyg., 53, 69-79.
405. Robinson, L.K. 1950 Effect of heat and of pH on strains of Coxsackie virus. Proc. Soc. Exp. Biol. Med., 75, 580-582.
406. Romer, P.H., and Joseph, K. 1910 Beitrag zur Natur des Virus der epidemischen Kinderlähmung. Munch. Med. Wochschr., 57, 347-348.
407. Rogers, L.A. 1914 The preperation of dried cultures. J. Infectious Diseases, 14, 100-123.
408. Rogers, L.A. 1949 An apparatus for the desiccation of cultures. J. Bact., 57, 137-140.
409. Rosebury, T. 1947 Experimental air-borne infection. Williams and Wilkins Co.
410. Rosebury, T., and Frances, S. 1950 Effects of storage in CO_2 ice on the viability of spirochetes and other anaerobic microorganisms isolated from the human mouth. J. Oral Surg., Oral Med. and Oral Path., 39, 1557-1561.
411. Rosebury, T., Kabat, E.A. 1947 Bacterial warfare. A critical analysis of the available agents, their possible military applications, and the means for protection against them. J. Immunol., Virus Res. and Exp. Chemother., 56, 7-96.
412. Rosen, H.R. 1938 Life span and morphology of fire blight bacteria as influenced by relative humidity, temperature, and nutrition. J. Agr. Research, 56, 239-258.
413. Rosenau, M.J. 1909 The viability of the tubercle bacillus. Gov't. Print. office, Washington.
414. Ross, O.A., and Bueding, E. 1950 Survival of Schistosoma mansoni in vitro. Proc. Soc. Exp. Biol. Med., 73, 179.
415. Roux, E. 1887 De l'action de la lumiere et de l'air. Ann. Inst. Pasteur, 1, 445.
416. Rubentschik, L., Roison, M.B., and Bieljamsky, E.M. 1936 Absorption of bacteria in salt lakes. J. Bact., 32, 11-31.
417. Russell, H.L. 1893 Bacteria in their relation to vegetable tissue. Johns Hopkins Hosp. Repts., 3, 223-263.
418. Rudolfs, W., Falk, L.L., and Ragotzkie, R.A. 1951 Contamination of vegetables grown in polluted soil. Sew. and Indust. Wastes, 23, 253-268.
419. Ruska, H. 1941 Uber den Einflub Keim schädigen der oder Keimabtötender Mabnahmen auf die Bakterienstruktur. Z. Hyg. Infektionskrankh., 123, 294-301.
420. Russell, H.L., and Fuller, C.A. 1906 The longevity of Bacillus typhosus in natural waters and in sewage. J. Infectious Diseases Supp., No. 2, 40.

421. Rymowitsch, F. 1902 Zur Züchtung des Pneumococcus. Centr. Bakt., I Abt. Orig., 32, 385-386.
422. Sanderson, E.S. 1925 Effect of freezing and thawing on the bacteriophage. Science, 62, 377.
423. Sanfelice, F. 1893 Untersuchungen über anaërobe Mikroorganismen. Z. Hyg. Infektionskrankh., 14, 339-392.
424. Schade, A.L., and Caroline, L. 1943 The preparation of a polyvalent dysentery bacteriophage in a dry and stable form. I. Preliminary investigations and general procedures. J. Bact., 46, 463-473.
425. Schade, A.L., and Caroline, L. 1944 The preparation of a polyvalent dysentery bacteriophage in a dry and stable form. II. Factors affecting the stabilization of dysentery bacteriophage towards heat, humidity, age and acidity. J. Bact., 48, 179-190, 243-251.
426. Schartner, R. 1939 Untersuchungen über den Keimgehalt von langdauernd tiefgekühlten Pocken-Rohstoffen. Zentr. Bakt. Abt. 1, 143, 168-172.
427. Schaughnessy, H.J., Harmon, P.H., and Gordon, F.B. 1930 Heat resistance of virus of poliomyelitis. J. Prev. Med., 4, 149.
428. Scherp, H.W., Flosdorf, E.W., and Shaw, D.R. 1938 Survival of influenza virus under various conditions. J. Immunol., 34, 447-454.
429. Schlote, A. 1948 Abtotung von Fleckfieber-rickettsien durch einige Wasch-und Disinfektionsmittle. Zentr. Bakt. I Abt. Orig., 152, 414-419.
430. Schlotthauer, H.L. 1940 Aircraft as disease carriers. California and Western Med., 53, 33.
431. Schoening, H.W., Dale, C.N., Mott, L.O., and Habermann, R. T. Pathogenicity of Salmonella cholerasuis: maintaining virulence by lyophilization. Amer. J. Vet. Res., 10, 101-110. 1949.
432. Schofield, F.W. 1916 Pathogenicity and longevity in diphtheria bacilli. Am. J. Pub. Health, 6, 1303.
433. Schultz, N.K. 1901 Ueber die Lebensdauer von Bacillus pestis hominis in Reinkulturen. Centr. Bakt., 29, 169-174.
434. Sears, H.J. 1946 Survival for fourteen years of agar slant cultures of Escherichia coli-mutabile without loss of important characters. J. Bact., 51, 553-558.
435. Seelemann, M., and Sieg, G. 1938 Zur Frage der Hitzewiderstandsfahgkeit der Brucella abortus und ihre Bedeutung für die Pasteurizierung der Milch. Molkereizta Hildesh., 52, 3047-3050.
436. Selbie, F.R. 1943 Viability of Spirochaeta pallida in stored plasma. Brit. J. Exp. Path., 24, 150-152.
437. Sergent, A. 1938 Fievre recurrente A Spirocheta hispanicum en Algerie. Transmission par le Rhipicephale du chien premunition serum de convalescents. Ann. Inst. Pasteur, 61, 217-254.
438. Shackell, L.F. 1909 An improved method of desiccation, with some applications to biological problems. Am. J. Physiol., 24, 325.
439. Shattock, S.G. 1911 The vitality of B. Pyocyaneus. Lancet, London, 1, 1455.

440. Shattock, S.G., and Dudgeon, L.S. 1912 Certain results of drying non-sporing bacteria in a charcoal liquid air vacuum. Proc. Roy. Soc. London, Series B, 85, 127-138.
441. Shaughnessy, H.J., and Criswell, K.I. 1925 Studies on salt action. X. The influence of electrolytes upon the viability and electrophoretic migration of Bacteria coli. J. Gen. Physiol., 9, 123-136.
442. Shaughnessy, H.J., and Falk, I.S. 1924 The effects of some electrolytes on the buffering capacity of Bacterium coli. J. Bact., 9, 559-579.
443. Sherman, J.M., and Cameron, G.M. 1934 Lethal environmental factors within natural range of bacterial growth. J. Bact., 27, 341-348.
444. Sherman, J.M., and Naylor, H.B. 1942 Ageing without reproduction and the viability of young bacterial cells at low temperature. J. Bact., 43, 749-756.
445. Shope, R.E. 1926 The survival of the tubercle bacillus in suspension in physiological salt solution. J. Exp. Med., 44, 623.
446. Sichert-Modrow, I. 1930 Haltbarkeit des Maul-und Klavenseucheerresers bei verschied enen Temperaturen. Centr. Bakt. Abt. I, 119, 17-19.
447. Sierakowski, S., and Milejkowska, F. 1924 Bactericidal action of different hydrogen-ion concentrations on different species of bacteria. Compt. rend. soc. biol., 91, 714-715.
448. Sierakowski, S., and Zabludowska, F. 1930 Hydrogen ion concentration limit of bacteriophage. Compt. rend. soc. biol., 103, 422-424.
449. Simmons, J.S. 1923 The isolation and cultivation of tubercle bacilli protected from light. Am. Rev. Tuberc., 8, 165-169.
450. Skidmore, L.V. 1932 The transmission of fowl cholera to turkeys by the common house fly, with brief notes on the viability of fowl cholera microorganisms. Cornell Vet., 22, 281-285.
451. Smart, H.F. 1935 Growth and survival of micro-organisms at sub-freezing temperatures. Science, 82, 525.
452. Smith, C.R. 1942 Survival of tubercle bacilli. The viability of dried tubercle bacilli in unfiltered room-light, in the dark and in the refrigerator. Am. Rev. Tuberc., 45, 334-345.
453. Smith, D.T., and Martin, D.S. 1948 Zinsser's Textbook of Bacteriology, 9th Ed.
454. Smith, E.F., and Swingle, D.B. 1905 The effect of freezing on bacteria. Science, 21, 481-482.
455. Snyder, J.C. 1947 Typhus fever in the second world war. California Med., 66, 3-10.
456. Sommer, E.W. 1930 Heat resistance of the spores of Clostridium botulinum. J. Infectious Diseases, 46, 85-114.
457. Spencer, R.R., and Melroy, M.B. 1942 Effects of carcinogens on small organisms; exposure of bacteria to high temperatures. J. Nat. Cancer Inst., 3, 1-5.
458. Spencer, R.R., and Melroy, M.B. 1949 Studies of survival of unicellular species. I. Variations in life expectancy of a paramecium under laboratory conditions. J. Nat. Cancer Inst., 10, 1-10.

459. Spencer, R.R., and Parker, R.R. 1924 U.S. Pub. Health Repts., 39, 55.
460. Stadler, W. 1899 Uber die Einwerkung von Kochsalz auf Bakterien. Arch. Hyg., 35, 40.
461. Stakman, E.C. 1942 The field of extramural aerobiology. Aerobiology, No. 17, 1-7.
462. Stamp, Lord 1947 The preservation of bacteria by drying. J. Gen. Microbiol., 1, 251-265.
463. Stanley, W.M. 1946 Viruses. Currents in Biochem. Research.
464. Stark, C.N., and Herrington, B.L. 1931 The drying of bacteria and the viability of dry bacterial cells. J. Bact., 21, 13.
465. Starzyk, J. 1936 Vitalite, toxicite et pouvoir d'immunisation de Rickettsia prowazeki conservees hors de l'organisme du pou, en milieu liquide et en milieu sec. Compt. rend. soc. biol., 123, 1221-1225.
466. Stearn, E.W. 1923 A study of the effect of gentian violet on the viability of some water-borne bacteria. Am. J. Pub. Health, 13, 567-570.
467. Stein, C.D. 1947 Some observations on the tenacity of Bacillus anthracis. Vet. Med., 42, 13-22.
468. Stein, C.D., and Rogers, H. 1950 Recovery of viable microorganisms and viruses from vapors removed from frozen suspensions of biologic material during lyophilization. Am. J. Vet. Res., 11, 339-344.
469. Stenstrom, W., and Gaida, J.B. 1931 Action of ultraviolet rays on new and old bacterial cultures. Proc. Soc. Exp. Biol. Med., 28, 898-902.
470. Sterzi, G., and Standkcher, V. 1939 Tentativi di coltura della spirocheta di schandium sulla membrano corionallantoidga de embrione de pollo vivente. Gior. Ital. di Dermat. e Sif., 80, 777.
471. Stille, B. 1943 Uber den Verlauf des Absterbens von Mikroorganismen bei wiederholtem Gefrieren. Arch. Mikrobiol., 13, 293-300.
472. Stillman, E.G. 1940 The viability of pneumococci in dried rabbit blood. J. Infectious Diseases, 66, 171-173.
473. Stillman, E.G. 1941 The preservation of pneumococcus by freezing and drying. J. Bact., 42, 689-693.
474. Stimson, A.M. The longevity of B. typhosus outside of the human body. Hyg. Lab. Bull., 35, 177-191.
475. Stock, C.C., and Francis, T.J. 1940 The inactivation of virus of epidemic influenza by soaps. J. Exp. Med., 71, 661-681.
476. Stockman, S., and Minett, F.C. J. Comp. Path. Therap., 39, 1-30.
477. Stockmayer, W. 1935 Vergleichende Untersuchungen über den Bangbakteriengehalt von Rahm, Butter, Mager- und Buttermilch, Sowie Versuche über die Konservierung von Milchproben. Zentr. Bakt. Abt. I Orig., 133, 425-435.
478. Stuart, C.A. 1924 The effect of environmental changes on the growth, morphology, physiology and immunological characteristics of Bacterium typhosum. J. Bact., 9, 581-602.
479. Sulkin, S.E., and Pike, R.M. 1951 Survey of laboratory-acquired infections. Am. J. Pub. Health, 41.

480. Surgalla, M., Seagalove, M., and Dack, G.M. 1944 Growth of food poisoning strain of alpha-type of streptococcus experimentally inoculated into canned foods. Food Research, 9, 112-114.
481. Swann, M.B.R. 1924 On the germination period and mortality of the spores of Bacillus anthracis. J. Path. Bact., 27, 130-134.
482. Sweany, H.C., and macLane, C.C. 1919 Relation of dust to the spread of tuberculosis. Illinois Med. J., 36, 302-305.
483. Swift, H.F. 1921 Preservation of stock cultures of bacteria by freezing and drying. J. Exp. Med., 33, 69.
484. Swift, H.F. 1937 A simple method for preserving bacterial cultures by freezing and drying. J. Bact., 33, 411-421.
485. Tanner, F.W. 1934 Microbiological examination of fresh and frozen fruits and vegetables. Am. J. Pub. Health, 24, 485-492.
486. Tanner, F.W., Beamer, P.R., and Richer, C.J. 1940 Further studies on development of Clostridium botulinum in refrigerated foods. Food Research, 5, 323-333.
487. Tanner, F.W., and Geen, H. 1930 Residual germicidal action of water and plain agar after exposure to ultraviolet irradiation. Proc. Soc. Exp. Biol. Med., 28, 291-293.
488. Tanner, F.W., and McCrea, F.D. 1923 Resistance of spores to moist heat. J. Bact., 8, 269-276.
489. Tanner, F.W., and Oglesby, N.I. 1936 Food Research, 1, 481-494.
490. Tanner, F.W., and Wallace, G.I. 1931 Effect of freezing on microorganisms in various menstra. Proc. Soc. Exp. Biol. Med., 29, 32-34.
491. Tanner, F.W., and Williamson, B.W. 1928 Effect of freezing on yeasts. Proc. Soc. Exp. Biol. Med., 25, 377-381.
492. Tashiro, Y. 1932 Experimental investigation on sterilization of water in common bath for sailors; viability of bacilli in water of proper temperature for bathing. Bull. Nav. Med. Assoc., Japan, 21, 4-6.
493. Tatum, E.L. 1945 X-ray induced mutant strains of coli. Proc. Nat. Acad. Sci., 31, 215-219.
494. Tetsumoto, S. 1930 Numerical variation and surviving period of Vibrio cholerae placed on aquatic food preparations. Jap. J. Exp. Med., 8, 353-363.
495. Tetsumoto, S. 1930 Numerical variation and surviving period of Bacillus typhosa placed on fresh aquatic products. Jap. J. Exp. Med., 8, 627-631.
496. Thom, C., Edmondson, R.B., and Giltner, L.T. 1919 Botulism from canned asparagus. J. Am. Med. Assoc., 73, 907-912.
497. Thomas, S., and Kreidler, W.A. 1925 The effect of freezing on Eberthella typhi. Abstracts Bact., 9, 25.
498. Thompson, R.L., and Coates, M.S. 1942 The effects of temperature upon the growth and survival of myxoma, herpes and vaccinia viruses in tissue culture. J. Infectious Diseases, 71, 83-85.

499. Thomson, St.C., and Hewlett, R.T. 1896 The fate of micro-organisms in inspired air. Lancet, 1, 86.
500. Tinker, I.S., and Rudnew, G.P. 1930 Zum Studium über die Lebensfahigkeit des Bacillen pestis. Arch. Schiffs-Tropen-Hyg., 34, 554-559.
501. Tinti, M. 1923 Der Einfluss der Temperaturerhöhungen auf die Oberflächenspannung bei werschiedenen Bacterienarten. Z. Immunitatsforsch. Exp. Therap., 36, 337-347.
502. Tohyama, Y. 1925 Experimental investigations concerning the prevention of epidemic diseases due to aquatic products. Sci. Repts. Govt. Inst. Infectious Diseases, Tokyo, 4, 169-222.
503. Tohyama, Y. 1930 Experimental investigations concerning prevention of epidemic diseases due to aquatic products; resisting power of Vibrio cholerae against low temperature. Jap. J. Exp. Med., 8, 327-352.
504. Toomey, J.A. 1937 Inactivation of poliomyelitis virus by ultraviolet irradiation. Am. J. Diseases Children, 53, 1490.
505. Topley, W.W., and Wilson, G.S. 1936 The principles of bacteriology and immunity. Second Ed., London.
506. Topley, W.W., and Wilson, G.S. 1946 The Principles of Bacteriology and Immunity.
507. Topping, N.H. 1940 The preservation of the infectious agents of some of the rickettsioses. U.S. Pub. Health Repts., 55, 545-547.
508. Truche, C., and Cotoni, L. 1912 Etudes sur le pneumocoque. V. Virulence des pneumocoques, humains et animaux, pour le lapin et le cobaye. Ann. Inst. Pasteur, 26, 530-535.
509. Trussell, R.E. 1947 Trichomonas vaginalis and trichomoniasis.
510. Turner, T.B. 1938 Preservation of virulent Treponema pallidum and T. pertenue in frozen state; with a note on preservation of filterable viruses. J. Exp. Med., 67, 61.
511. Turner, T.B., and Brayton, N.L. 1939 Factors influencing the survival of spirochetes in the frozen state. J. Exp. Med., 70, 639-650.
512. Turner, T.B., and Fleming, W.L. 1939 The prolonged maintenance of spirochetes and felterable viruses in the frozen state. J. Exp. Med., 70, 629-637.
513. Twitchell, D.C. 1906 Vitality of tubercle bacilli in sputum. Trans. Nat. Assn. for Study and Prev. of Tuberc., 1, 221.
514. Ungar, J. 1949 Viability of freeze-dried BCG cultures. Tubercle, 30, 2-4.
515. Ungerman, N.I. 1918 Arb. Kaiserl. Gesundh., 51, 199.
516. Urbain, A., Guillot, G., and Vallee, M. 1930-1931 Longevity of Preisz-Nocard bacillus. Compt. rend. soc. biol., 105, 676-677.
517. Vaillard, L., and Dopter, C. 1903 Ann. Inst. Pasteur, 17, 463.
518. Van Deinse, F., and Senechal, F. 1950 Freeze-dried (lyophilized) BCG. Tubercle, 31, 157-163.
519. Van Eseltine, W.P., and Rahn, O. 1949 The effect of temperature upon bacteriostasis. J. Bact., 57, 547-554.

520. Van Rooyen, C.E., and Rhodes, A.J. 1940 Virus diseases of man. Oxford U. Press, London.
521. Vazques-Colet, A.T. 1936 Med. J. Philippine Islands, M.A., 16, 231.
522. Vedder, A. 1932 Resistance to heat shown by dried bacteriophages. Centr. Bakt. Abt. 1, 125, 111-114.
523. Velu, H. 1931 Longevity of anthrax spores in glycerinated medium, and standardization of vaccines. Compt. rend. soc. biol., 108, 685-686.
524. Velu, H., Pigoury, L., and Courtrade, R. 1942 Behavior of glanders bacilli dried under vacuum after freezing. Compt. rend. soc. biol., 136,775-776.
525. Verge, J., and Grasset, E. 1928 Growth of bacteria in eggs at laboratory temperature and in frozen state. Compt. rend. acad. sci., 186, 718-719.
526. Verwey, W.F., and Matt, C. 1950 Viability of restored desiccated Brucella abortus vaccine. J. Am. Vet. Med. Assoc., 116, 296-297.
527. Vidal, C.B. 1934 Viability of tubercle bacilli in tissues and sputum preserved in vitro. Am. Rev. Tuberc., 30, 345.
528. Von Albrecht, H., and Ghon, A. 1901 Ueber die Aetiologie und pathologische der Meningitis cerebrospinalis epidemica. Wein. Klin. Wockschr., 14, 984-996.
529. Wahl, R. 1946 Effect of light on bacteriophages. Ann. Inst. Pasteur, 72, 284-287.
530. Wadsworth, A. 1903 A convenient method for growing and storing virulent pneumococci. Proc. New York Path. Soc., 3, 113-117.
531. Walker, E.L., and Sallards, A.W. 1913 Experimental entamoebic dysentery. Philippine J. Sci., 8, 253.
532. Ward, H.M. 1892 Proc. Roy. Soc., London, 52, 393.
533. Washbourn, J.W. 1896 Experiments with the pneumococcus, with especial reference to immunity. J. Path. Bact., 3, 214.
534. Watkins, J.H., and Winslow, C.E.A. 1932 Factors determining rate of mortality of bacteria exposed to alkalinity and heat. J. Bact., 24, 243-265.
535. Wattie, E., and Chambers, C.W. 1943 Relative resistance of coliform organisms and certain enteric pathogens to excess-lime treatment. J. Am. Water Works Assoc., 35, 709-720.
536. Watts, P.S. 1941 Vet. Record, 53, 61.
537. Webb, G.B., Ryder, C.T., and Gilbert, G.B. 1921 The survival and virulence of tubercle bacilli in excised animal lymph nodes. Am. Rev. Tuberc., 5, 388-396.
538. Wehmer, N.I. 1897 Centr. Bakt. 2 Abt.
539. Weil, M., Beard, D., Beard, J. 1948 pH stability, response to antibiotics and factors influencing egg-culture of mumps virus. Proc. Soc. Exp. Biol. Med., 68, 308-309.
540. Weil, M., Beard, D., Sharp, D., and Beard, J. 1948 Purification, pH stability and culture of the mumps virus. J. Immunol., Virus Res. and Expts. Chemother., 60, 561-582.
541. Weinzirl, J. 1907 The action of sunlight upon bacteria with special reference to B. tuberculosis. J. Infectious Diseases, Suppl. No. 3, 4, 128-153.
542. Weinzirl, J. 1914 The germicidal action of sunlight upon bacterial spores. Am. J. Pub. Health, 4, 969-974.

543. Weinzirl, J. 1914 The germicidal action of sunlight upon bacterial spores. Am. J. Pub. Health, New York, 4, 969-974.
544. Weiser, R.S., and Hargiss, C.O. 1946 Studies on the death of bacteria at low temperatures. II. The comparative effects of crystallization, vitromelting, and devitrification of the mortality of Escherichia coli. J. Bact., 52, 71-79.
545. Weiser, R.S., and Osterud, C.M. 1945 Studies on the death of bacteria at low temperatures. I. The influence of the intensity of the freezing temperature, repeated fluctuations of temperature, and the period of exposure to freezing temperatures on the mortality of Escherichia coli. J. Bact., 50, 413-439.
546. Weiss, N.I. 1894 Ueber das Verhalten der Cholera-Erreger bei niedrigen Temperaturen. Z. Hyg., 18, 492-499.
547. Weiss, H. 1921 Heat resistance of spores, with special reference to spores of B. botulinus. J. Infectious Diseases, 28, 70.
548. Wesbrook, F.F. 1896 Some of the effects of sunlight on tetanus cultures. J. Path. Bact., 3, 70.
549. Wesselinoff, W. 1949 Beitrag zum Rationalisieren der Bunten-Reihe Durch Anwendung der Mikropipetten. Zentr. Bakt. I. Abt. Orig., 154, 217-219.
550. White, A.C. 1901 Possibilities of liquid air to the physician. J. Am. Med. Assoc., 36, 426-428.
551. Whitman, L. 1948 The prolonged viability of sporozoites of Plasmodium gallinaceum in extracts of washed chicken erythrocytes. J. Immunol., Virus-Res. and Exptl. Chemother., 59, 285-294.
552. Wickerham, L.J., and Flickinger, M.H. 1946 Viability of yeasts preserved two years by the lyophil process. Brewers Digest, 21, 48T-52T, 58T.
553. Wile, U.J., and Snow, J.S. 1941 Chick embryo as a culture medium for Spirochaeta pallida. J. Invest. Dermatol., 4, 103.
554. Williams, O.B. 1929 Some factors influencing the heat resistance of bacterial spores. J. Bact., 17, 16.
555. Williams, O.B. 1948 Studies on spore formation and spore resistance. Texas Repts. Biol. Med., 6, 405-413.
556. Williams, O.B., and Harper, O.F., Jr. 1951 Studies on heat resistance. J. Bact., 61, 551-556.
557. Williams, O.B., and Zimmerman, C.H. 1951 Studies on heat resistance. III. The resistance of vegetative cells and spores of the same organism. J. Bact., 61, 63-65.
558. Wilson, J.A. 1919 Bacteriology of certain filter-passing organisms. Brit. Med. J., 1, 602.
559. Wilson, R.J. The viability of the Bacillus pestis in stock cultures. Proc. N.Y. Path. Soc., 13, 149-150.
560. Winslow, C.E.A., and Abramson, F. 1911-1912 The effect of drying upon the viability of bacteria. Proc. Soc. Exp. Biol. Med., 9, 107.
561. Winslow, C.E.A., and Brooke, O.R., Jr. 1927 Viability of various species of bacteria in aqueous suspensions. J. Bact., 13, 235-243.

562. Winslow, C.E.A., and Dolloff, A.F. 1928 Relative importance of additive and antagonistic effects of cations upon bacterial viability. J. Bact., 15, 67-92.
563. Winslow, C.E.A., and Falk, I.S. 1919 The effect of mineral salts upon the viability of bacteria in water. Abstr. Bacteriol., 3, 5.
564. Winslow, C.E.A., and Falk, I.S. 1923 Studies on salt action. VIII. The influence of calcium and sodium salts at various hydrogen ion concentrations upon the viability of Bacterium coli. J. Bact., 8, 215-244.
565. Winslow, C.E.A., and Falk, I.S. Studies on salt action. I. Effect of calcium and sodium salts upon the viability of the colon bacillus in water. Proc. Soc. Exp. Biol. Med., 15, 67.
566. Wooley, J.G. 1939 The preservation of lymphocytic choriomeningitis and St. Louis encephalitis viruses by freezing and drying in vacuo. U.S. Pub. Health Rep., 54, 1077.
567. Worth, C. 1919 A culture medium for the maintenance of stock cultures of bacteria. M. J. Bact., 4, 603-608.
568. Wuknow, N.I. 1893 Ueber die Wirkung der niederen Temperatur auf Cholera vibrionen. Centr. Bakt., 14, 770.
569. Wyant, Z.N., and Normington, R. 1920 Influence of various chemical and physical agencies upon Bacillus botulinus and its spores. J. Bact., 5, 553-557.
570. Wyckoff, R.W.G., and Beard, J.W. 1937 pH stability of Shope papilloma virus and purified papilloma virus protein. Proc. Soc. Exp. Biol. Med., 36, 562.
571. Yaoi, H. 1924-1925 On the influence of acids upon the viability of bacteria. J. Lab. Clin. Med., 10, 735-751.
572. Yasukawa, Y. 1933 Experiments on sea water and Vibrio cholerae. Japanese J. Exp. Med., 11, 119-127.
573. Yesair, J., Bohrer, C.W., and Cameron, E.J. 1946 Effect of certain environmental conditions on heat resistance of micrococci. Food Research, 11, 327-331.
574. Young, V.M., Felsenfeld, O., and Byrd, C.L., Jr. 1949 Behavior of virus of poliomyelitis in a culture of Endamoeba histolytica. Am. J. Clin. Path., 19, 1135-1138.
575. Yourevitch, V. 1930 Culture latente pour la conservation des pneumocoques et d'autres microbes au point de vue de leur vitalite et de leur virulence. Compt. rend. soc. biol., 103, 320.
576. Zeug, M. 1920 Aequilibrierte Salylosungen aus indifferente Suspensions-flussigkeiten fur Bakterien. Arch. Hyg., 89, 175, 380.
577. ZoBell, C.E. 1939 The temperature tolerance of marine bacteria. Rept. Proc. 3rd Intern. Congr. Microbiol.
578. ZoBell, C.E., and ZoBell, M.H. 1932 Metabolism studies on the Brucella group. J. Infectious Diseases, 50, 538.
579. Zurhelle, E., and Strempel, R. 1927 Studien über Lebensfähigkeit und Virulenzerhaltung der Spirochaeta pallida in totem Gewebe. Arch. Dermatol. Syphilol., 153, 219-226.

References (Culture) Addendum

1a. Campbell, H. 1932 The viability and growth of certain microorganisms common to frozen-pack fruits and vegetables at temperatures below 32°F. Master's Thesis, Univ. of Wash. Libr.

2a. Lester, Wm. Jr. 1948 Influence of relative humidity on the infectivity of air-borne influenza a virus (Pr-8 Strain). Jour. Exptl. Med., 88, 361-368.

3a. Petri 1921 Quoted by Ravenel in article by G. B. Webb.

REFERENCES (CULTURE) ADDENDUM

1a. Bamberger, A. 1936 Resistance of dysentery and pseudodysentery bacilli to external influences. Zentblat. f. Bakt., abt. (1) 137, 142-151.

2a. Buchanan, G. E. 1918 Study of outbreak of bacillary dysentery. Lancet, 2, 166.

3a. Campbell-Renton, M.L. 1941 Experiment on drying and freezing bacteriophage. J. Path & Bact., 53, 371-384

4a. Eigelsbach, H.T. 1951 Studies on variation of Bacterium tularense., J. Bact., 61 (5), 557-569.

5a. Gordon, M.H. 1926 Studies of viruses of vaccinia and variola. Med. Res. Council, Special report series., 98, London, His Majesty's Stationery Office.

6a. Hastings, E.G. 1923 Comparative resistance of bacteria from native habitats and from artificial culture., 33, J. Infect. Dis., 33, 526-230.

7a. Hutton, R.S., Hilmoe, R.J., Roberts, J.L. 1951 Some physical factors that influence the survival of Brucella abortus during freeze-drying., J. Bact., 61(3), 309-319

8a. Shaughnessy, H.V. 1930 The heat resistance of the virus of polio. J. Prev. Med., 4, 149-155.

9a. Watts, P.S. 1945 Effect on survival of dried cultures of Strep. agalactiae J. Path. Bact., 57, 191-197.

The following authors appear in the references but specific information pertaining to their work does not appear in the tables:

Andrews, W.	1931
Ballantyne, E.N.	1930
Berry, H.	1948
Borman, E. K.	1932
Buchbinder, L.	1941
Chapman, G.H.	1936
Cohn, F.	1872
Cramarossa, S.	1927
Dautrebande, L.	1948
Dold, H.	1947
Downes, A.	1877
Dubos, R.J.	1950
Fasquelle, R.	1951
Foda, I.O.	1950
Frankland, P.F.	1894
Germano, E.	1897
Gibbons, N.E.	1943
Gilcreas, F. W.	1950
Graham-Smith, G.S.	1930
Haines, R.B.	1937
Hankin, E.	1896
Hartsell, S.E.	1951
Hinds, M.E.	1921
Hirsch, J.	1933
Hoder, F.	1928
Holland, [illegible]	1922
[illegible], R.	1949
Irwell, W.	1894
Jettmar, H.M.	1927
Kaess, G.	1935
King, A.G.	1930
Koser, S.A.	1917
Landsteiner, K.	1911
Laser, H.	1891
Lee, R.E.	1918
Levine, M.	1921
Lionetti, G.	1937
Loewenthal, N.I.	1906
Luria, S.E.	1946
Macchiavello, A.	1937
McCormack, G.	1950
Melsens, M.	1870
Murray, C.	1932
Porter, J.R.	1947
Quastel, J.H.	1927
Rahn, Otto	1932
Rahn, Otto	1945
Raynor, A.G	1943
Rogers, L.A.	1949
Rosebury, T.	1947
Rosenau, M.J.	1909
Russell, H.L.	1893

The following authors appear in the references but specific information pertaining to their work does not appear in the tables.

Cont.

Shackell, L.F.	1909
Smith, D.T.	1948
Stanley, W.M.	1946
Starzyk, J.	1936
Stuart, C.A.	1924
Sulkin, S.E.	1951
Sweany, H.C.	1919
Topley, W.W.	1936
Winslow, C.E.A.	1919

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN FOOD

TABLE F1 THE SURVIVAL OF BACILLUS SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
B. anthracis			
Milk from udder of cow that had died of the disease	10 yr.	Morris	1921
DAIRY PRODUCTS			
B. sp.			
Margarine	Recov. 72%	Foltz	1951
CEREAL			
B. anthracis			
Oats	Present	McFadyean	1895
VEGETABLES			
B. anthracis			
Roots of corn	50 d.	Beranek	1948
Plants, lima bean	Recov. 6-11 d.	Russell	1893
FRUITS			
B. mycoides			
Fruits, -5F	Resisted -5 and 15F better than higher temp.	Campbell	1932

TABLE E21 THE SURVIVAL OF BRUCELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
Br. abortus			
Cream, 8C	Bovine strain 8 d.	Carpenter	1928
" "	Bovine & human strain 10 days	"	"
Sour milk	5 d.	Honda	1938
Milk, home pasteurized	Inoc:100,000/ml; 5-10min	Huddleson	1949
Raw milk	---	Jones	1943
Raw cream	Recov: 11 out of 13	Pullinger	1935
Sterilized and raw milk	Some after 50 min. recov	Seelemann	1938
Milk, 145F	30 min.	Smith	1932
" flash pasteurization	Org. survived	"	"
Milk, 4-8C, 18-19C, 22-24	Inoc:0.5 cc milk, 1-7 d.	Stockmayer	1935
Milk +0.25% Boric acid, 4-8C, 18-19C, 22-24C	" " " "	"	"
Milk+0.5% Boric acid, 4-8C, 18-19C, 22-24C	" " " "	"	"
Milk+1% Boric acid, 4-8C, 18-19C, 22-24C	" " " "	"	"
Milk+2% Boric acid, 4-8C, 18-19C, 22-24C	" " " "	"	"
Milk, R. T.	3-4 d.	Van Drimmelen	1948
Br. melitensis			
Sheep's milk, 16C, pH 6.8-6.0	22-40 d.	Versilova	1937
Sheep's milk, 16C, pH 4-5	30 d.	"	"
Milk, 37C	Few days	"	"
Br. suis			
Milk, 62C, open coil pasteurizer	4 min.	Murray	1932
Milk foam in outlet, 63C	30 "	"	"
DAIRY PRODUCTS			
Br. abortus			
Butter, 8C	81-32 d.	Carpenter	1928
" 46F	142 d.	"	"
Cheese	60 d.	Daklberg	1946
Butter, 8C	Inoc:artifical;32-142 d.	Fitch	1933
Ice cream	Present ---	"	"
Cheese	Few days	Pullinger	1935
Ice cream, 30F	1 mo.	Thompson	1933
Roquefort cheese	2 mo.	"	"
Cheese	2 "	Voille	1931
Ice cream, -23.2C	7 yr.	Wallace	1938
Butter and cheese	Few days	T & W	1946
Br. melitensis			
Goat cheese	Present ---	Eyre	
Cheese	Most common	Fabian	1947
Cheese of infected goat milk	6-20 d.	Peres	1936
Cheese from unpasteurized goat milk	38 d.-1 yr.	Stiles	1945
Brynza cheese, 11-14C	45 d.	Versilova	1937

TABLE E2 (cont'd) THE SURVIVAL OF BRUCELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY PRODUCTS (cont'd)			
<u>Br. melitensis</u>			
Ice cream, -23.2C	5 yr.	Wallace	1938
" "	30 mo. +	"	"
<u>Br. suis</u>			
Ice cream, -23.2C	4 yr.	"	"
Ice cream	30 mo. +	"	"
<u>Br. (spp.)</u>			
Butter from infected cow, salted and unsalted	4 mo.	Bryan	1944
Cheese, 4.4C	Inoc:1,000/ml;>6 mo.<1yr	Gilman	1946
Cheddar cheese	Inoc:700-800/ml;>3 mo. <1 yr.	"	"
" " , 1.1-2.7C	>41 d.-84 d.	"	"
Cheese	Acidity decreases viability of org.	Lerche	1931
MEAT			
<u>Br. melitensis</u>			
Cured ham, nat. infection, in ice box	21 d, none after smoking	Hutchings	1951
BEVERAGES			
<u>Br. abortus</u>			
Beer	3 d.	Serpa Santos	1939
Wines	1 hr.	" "	"

TABLE E3 THE SURVIVAL OF CLOSTRIDIUM SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY			
Cl. (spp.)			
Cheese	Most common	Fabian	1947
MEAT			
Cl. botulinum			
Cooked meat and fish	Spores present	Editorial	1926
Canned salmon, beef, sardines, clam juice, duck	" "	"	"
Cl. sporogenes			
Putrid meat, 50C	No growth in 9 d.	Haines	1944
Spore forming anaerobes			
Roast beef, canned in 1824	3 strains viable	Wilson	1938
Tripe, canned 1880	Not found	"	"
Cl. (spp.)			
Salted fish	---	T & W	1946
Cooked meat and fish	---	"	"
VEGETABLE			
Cl. tetani			
Various vegetables	Present	Dubovsky	1922
Cl. botulinum			
Home canned string beans, corn, asparagus, spinach, pinento, pickles	Spores present	Editorial	1926
Vegetables grown in contaminated soil	Present	Parry	1946
Peas, string beans, corn, and spinach; 10-12C, 19-21C, and 24-26C	>3 mo.	Starin	1926
Peas, 10F	No toxin was produced when containers were defrosted and immediately examined or when stored in ice box 3 d.	Straka	1932
Peas, frozen, 42F, pH 5.6-6.5	Inoc.100,000,000;Recov.0; <7 d.	Straka	1938
Peas, frozen, 50F	Inoc:conc;Recov.0; >7 d.	"	"
Peas, frozen, 60F, pH 4.6-6.7	>3 d.	"	"
Peas, frozen, 60F, pH 4.6-6.2	>6 d.	"	"
Peas, frozen, 80F, pH 4.3-6.6	Inoc:conc;> 2 d.	"	"
Vegetables, -16C	>2 yr.	Tanner	1931
" "	14 mo.	"	"
" 100C	90-80 min.	Weiss	1921
" 105C	30-70 "	"	"
" 110C	10-20 "	"	"
Spore forming anaerobes			
Carrots, canned 1885	Not found	Wilson	1938
Cl. (spp.)			
Cans of spinach	Inoc:800,000;50% of the org. died in 18 hr.	Koser	1921

TABLE E3 (cont'd) THE SURVIVAL OF CLOSTRIDIUM SPECIES IN FOOD

Factor(s)	Survival	Reference	
FRUIT			
Cl. sporogenes			
Dried fruit, 45C	Grown in 24 hr.	Haines	1944
Cl. (spp.)			
Fruit, -5F	140 d.	Campbell	1932
" -16C	>2 yr.	Tanner	1931
GENERAL FOOD			
Cl. botulinum			
Various foods, 35C, artificially contaminated	Recov:certain toxin;1 yr.	Schoenholz	1923
Variety of foods, -16C	1 yr.	Wallace	1933
Acid foods, 100C	50 min.	Weiss	1921
" " 105C	30 "	"	"
" " 110C	15 "	"	"
Various types of food	---	T & W	1946

TABLE E-1 THE SURVIVAL OF ESCHERICHIA COLI IN FOOD
ALSO PARACOLOBACTRUM & AEROBACTER

Factor(s)	Survival	Reference	
MILK			
E. coli			
Cream, 30% butter fat, freezing at -15C	Reduction 61% in 3 hr.	Hilliard	1915
Milk dil., frozen	Less dil. the larger the survival	Keith	1913
Milk, -21 to -78C	Inoc. 100,000/ml., more resistant to freezing than thawing	Lund	-
" pH 4.2	Growth checked	Palladina	1935
" plus 5% NaCl, pH4.6	24 hr.	"	"
Skim milk or cream, 20C	Well	Robinton	1945
DAIRY PRODUCTS			
E. coli			
Milk curds	48-96 hr.	Bhat	1949
Cheese	12 mo.	Crossley	1942
Margarine	Isolated from 8%	Foltz	1951
Ice cream	In 90% of samples	Murgia	-
Butter and margarine, rapid develop. of acidity and prompt salting	Check growth	Palladina	1935
Butter, 14F	8 wk.	Rice	1938
" 60F	Did not mult. but survived long	"	"
EGGS			
E. coli			
Frozen eggs	Recov. 50% colonies examined were coliform	Colien	1942
" " , -9C	14 mo.	Hartsell	1951
Egg whites, -15C	Recov. 0, 3 mo.	Johns	1946
Frozen eggs (white)	" <10, 5 yr.	Schneiter	1943
" " (yolk)	" 4000, 5 yr.	"	"
MEAT			
E. coli			
Salt fish blocks, 5-6C	72 d.	Frank	1941
Frozen shrimp	In 60% of all samples	Holmes	1949
Fish and meat		Ignatovich	1935
Sausage, 6 d. drying	13 d.	Mueller-Claus	1938
" 35C	>24 hr.	" "	"
VEGETABLES			
E. coli			
Veg, 20C	Recov. 60% out of 70 for 1 yr.	Burton	1949
Cantaloupes, -4F	>1 yr.	"	"
Veg.	In 90% of samples	Murgia	-
Tomatoes with bacteria sprayed on	5 min.	Rudolfs	1951
Mushrooms, -9.4C	6 mo.	Smart	1934
FRUITS			
E. coli			
Fruits	In 90% of samples	Maurgia	-
Fruit in cold water	Recov. 100%, few min.	Spaini	1944

TABLE E4 (CONT'D) THE SURVIVAL OF ESCHERICHIA COLI IN FOOD ALSO PARACOLOBACTRUM & AEROBACTER

Factor(s)	Survival	Reference	
FRUITS (cont'd)			
E. coli			
Fruit in boiling water	Recov. 70%, few min.	Spaini	1944
Cherries, -17.8 and -40C	2-3 mo.	Wallace	1933
Cherry juice, -17.8 and -40C	<4 mo.	"	"
Good oranges, 17.8C, pH 3.64	Inoc. 12,300/cc, Recov. 2,800/cc, 7 mo.	Wolford	1948
Soft rotten oranges, 17.8C pH 3.74	Inoc. 31,500,000/cc, Recov. 1,250,000/cc, 8 mo.	"	"
BEVERAGES			
E. coli			
Beer	Contained many, from water to dilute beer	Buttiaux	1949
MILK			
A. aerogenes			
Milk, pH 4.2	Growth checked	Palladina	1935
" 5% NaCl, pH 4.6	24 hr.	"	"
DAIRY PRODUCTS			
A. aerogenes			
Butter, 14F	8 wk.	Rice	1938
Salted butter, 60F	Did not mult. but survived long	"	"
EGGS			
P. sp.			
Turkey and chicken egg albumin , incubated	Slight effect on bacteria	Gregory	1948
VEGETABLES			
A. aerogenes			
Cantaloupes, -4F	>1 yr.	Burton	1949
BEVERAGES			
A. sp.			
Beer	Contained 1000/ml	Buttiaux	1949

TABLE E5 THE SURVIVAL OF MICROCOCCUS SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
M. aureus			
Milk, 65-81C	Recov. 0, 1 d.	Lazarus	1890
" -21 to -78C	Inoc. 100,000/ml., more resistant to freezing than thawing	Lund	-
DAIRY PRODUCTS			
M. sp.			
Margarine	56%	Foltz	1951
EGGS			
M. aureus			
Egg powdered, R.T., stored in packet	Inoc. 2,000, Recov. 20, 70 d.	Haines	1944
Frozen eggs, -9C	12 mo.	Hartsell	1951
MEAT			
M. aureus			
Putrid meat, 44C	No growth	Haines	1944
Canned roast beef, 22-37C	Inoc. 30-5000 org./gm., >60 d.	Surgella	1945
SAUCE			
M. spp.			
Salad dressing and mayonnaise,	M. more resistant than S.	Wethington	1950
Mayonnaise, 37C, pH 3.8, 0.48% acid	96 hr.	"	"
Salad dressing, 37C, pH 3.2, 1.1% acid	30 hr.	"	"
Mayonnaise with egg yolk, 0.51% acid, pH 4.0, fresh	78 hr.	"	"
Mayonnaise with egg yolk, 0.51% acid, pH 4.0, emulsol	72 hr.	"	"
Salad dressing with egg yolk, 1.02% acid, pH 3.30, fresh	48 hr.	"	"
Salad dressing with egg yolk, 1.02% acid, pH 3.30, emulsol	16 hr.	"	"
Mayonnaise, pH 5.0, 0.15% acid	144 hr.	"	"
Salad dressing, pH 5.0, 0.15% acid	144 hr.	"	"
VEGETABLES			
M. aureus			
Plants, lima beans	Recov. 3, 13 d.	Russell	1893
M. sp.			
Asparagus, -17.8C	Inoc. 255% Recov. 85.8%, 8 mo.	Lockhead	1938
Spinach, -17.8C	Inoc. 8.6%, Recov. 63.2%, 8 mo.	"	"
Peas, -17.8C	Inoc. 21.3%, Recov. 44.4%, 8 mo.	"	"

TABLE 55 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES IN FOOD

Factor(s)	Survival	Reference	
VEGETABLES (cont'd)			
M. sp.			
Beans, -17.8C	Inoc. 7.0%, Recov.72.0%, 8 mo.	Lockhead	1938
Corn, "	Inoc.20.7%, Recov.78.7%, 8 mo.	"	"
FRUITS			
M. aureus			
Dried fruit, 44C	No growth	Haines	1944
Sliced sweetened straw-berries, -18C	Inoc. 500/gm., 6 mo.	McCleskey	1941
M. sp.			
Orange juice, -4C	50 hr.	Beard	1932

TABLE E6 THE SURVIVAL OF MICROORGANISMS IN FOOD

Factor(s)	Survival	Reference	
MILK			
Corynebacterium diphtheriae			
Cream, frozen	>4 d.	Bolten	1918
Milk	Present	Trevelyan	1898
Lactobacillus casei			
Milk, -21 to -78C	Inoc. 100,000/ml., more resistant to freezing than thawing	Lund	-
Lactobacillus acidophilus			
Milk, 116C	15 min.	Morrison	1930
Rickettsia spp.			
Ster. skim milk, 26-28C	Inoc. 0.5ml. of $2x10^{-1}$ cotton rat liver, 24 hr.	Anderson	1944
Raw milk	Not given	Huebner	1948
Rickettsia			
Coxiella burneti			
Milk, R.T.	7 d.	Babudieri	1950
" 37C, air dried stored	30 d.	"	"
DAIRY PRODUCTS			
Achromobacter delmarvae			
Butter	239 d.	Berry	1927
" and margarine, rapid develop. of acid and prompt salting	Growth checked	Palladina	1935
Bacterium linens			
Cheddar cheese, 10C, pH 5.13	4 mo.	Albert	1944
Corynebacterium diphtheriae			
Butter	1 mo.	Minn.St.Bd.of Health	1911
Rickettsia			
Coxiella burneti			
Cheese made with infected milk	46 d.	Babudieri	1950
Butter, below freezing	41 d.	Jellison	1948
Lactobacillus sp.			
Butter	275-462 D.	Tanner	1944
MEAT			
Corynebacterium diphtheriae			
Sausage, 85C for 70 min.	24 hr.	Mueller-Claus	1938
Animal parasites			
Trichinella spiralis			
Pork, -15C	24-36 hr.	Tanner	1944
Trichina larvae			
Pork, -27C	Recov. 0, 36 hr.	Gould	1949
" -30C	" " 24 hr.	"	"
" -33C	" " 10 hr.	"	"
" -35C	" " 40 min.	"	"
" -37C	" " 2 min.	"	"

TABLE E6 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN FOOD

Factor(s)	Survival	Reference	
CEREAL			
Pasteurella tularensis			
Grain	Present	Ayres	1948
" contaminated with urine or feces of infected mice	"	Zeiss	1943
VEGETABLES			
Lactobacillus cucumeris			
Peas, 15F	>2 yr.	Berry	1933
Lactobacillus spp.			
Veg., -10C	2 yr.	"	"
Peas, -10C	2 yr.	Weiser	1951
Pseudomonas aeruginosa			
Plants	Recov. many, 69 d.	Russell	1893
Bacteria and parasites			
Veg., from irrigation water	Found	Wright	1950
FRUIT			
Proteus vulgaris			
Cherry juice, -17.8C and -40C	<4 wk.	Wallace	1933
GENERAL			
Pasteurella tularensis			
Food stuff	Present	Schuller	1943
Food, contaminated with urine or feces of infected mice	"	Zeiss	1943

TABLE E7 THE SURVIVAL OF MICROORGANISMS IN FOOD (GENERAL)

Factor(s)	Survival	Reference	
MILK			
Milk, frozen and stored	Lowers no. of bacteria	Babcock	1947
Raw milk	Germicidal action decreases no.	Chambers	1920
Cream, -5 to -10F	Decreases during storage and freezing	Fabian	1943
Powdered skim milk, R.H. 5-20%	Inoc. 11,100/g. at 37C and 23,800/g at 30C, Recov. Max. survival, 48 wk.	Higginbottom	1948
Whole milk, 37C, R.H. 10-20%	Inoc. 91,000/g., Reduct. 99.9%, 72 wk.	"	"
Milk used in coffee or tea	Present	Hill	1909
DAIRY PRODUCTS			
Margarine	42% had plate cts. of 100/ml. or less	Foltz	1951
Ice cream	Lower in winter mo.	Tanner	1944
EGGS			
Powdered egg, 60C	99% reduct. 1 d., decrease proportional to increase in temp.	Gibbons	1943
Egg whites, frozen	Low cts.	Vergo	1928
" yolks, "	" "	"	"
" whites, R. T.	High cts.	"	"
" yolks, " "	" "	"	"
" , OF	Greater destruction of bacteria than at lower temp.	Winter	1947
MEAT			
Chicken-a-la-King	In ¼ samples of precooked food	Buchbinder	1949
Hamburger steak, unfrozen	Recov. >24,300/gm.	Geer	1933
" " frozen	" >1,100,000/gm.	"	"
Dehydrated meat, 15C, in air, R.H. 4.5%	Inoc. 700,000, Recov. 9,400; 10 wk.	Haines	1944
Dehydrated meat, 15C, in air, R.H. 2.0%	Inoc. 2,000,000, Recov. 37,000; 6 wk.	"	"
Dehydrated meat, 15C, in air	Inoc. 24,000,000; Recov. 29,300; 7 mo.	"	"
Dehydrated meat, 15C, in nitrogen	Inoc. 24,000,000; Recov. 669,000; 12 mo.	"	"
Shrimp, -40C	Recov. greatly reduced in peeled, >12 mo.	Holmes	1949
" -12C	More destrictive than lower temp.	"	"
Meat	Present	Jensen	1945
Lamb chop (fat), -6.6C	Recov. 38,300, 6 wk.	Prescott	1932
" " " -12C	" 44,400 " "	"	"
" " " -18C	" 67,700 " "	"	"
Fish (haddocks), -4C	Start 47, Recov. 260, 7 wk.	Prescott	1932
" " -6.6C	Start 47, Recov. 820 7 wk.	"	"

TABLE E7 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN FOOD (GENERAL)

Factor(s)	Survival	Reference	
MEAT (cont'd)			
Fish (haddocks), -12C	Start 47, Recov. 560, 7 wk.	Prescott	1932
" " -18C	Start 47, Recov. 75	"	"
VEGETABLES			
Frozen veg., -18C	>4 yr.	Berry	1937
Vegetable tissue	Present	Galippe	1887
Dried veg., 65-80C	"	Haines	1944
Frozen veg., 10, 0, -10F	Inoc. 50,000/g., Recov. no increase	Hucker	1951
Pickled veg.	Intestinal pathogens	Lin	1945
Vined peas, <40F	95% reduction	Link	1949
Frozen packed veg., -17.8C	Some present 9 mo.	Lockhead	1936
Peas, -20C, brine packed	24 wk.	MacFarlane	1940
Spinach, -6.6C	Start 2170, Recov. 1190, 6 wk.	Prescott	1932
" -12C	Start 2170, Recov. 1,350 6 wk.	"	"
" -18C	Start 2170, Recov. " 6 wk.	"	"
Veg., bact. in soil	No results	Remlinger	1909
Peas and whole kernel corn frozen in liquid air or in air blast	Did not mult.	Van Eseltine	1948
Veg.,	Low temp., moist soil, organic matter increase viability of pathogenes and other pathogenes reduce survival	Rudolfs	1950
FRUITS			
Berries, airtight, frozen	Large decrease, greater decrease at high temp.	Berry	1933
Apple juice, -70 to -21C	Reduced 90-96% 1 mo.	"	1932
" " -5, -9.4, 6-7C	Survival <10% 1 mo.	"	1934
Frozen berries,	Death more rapid at -9.4C than at -20.6C	"	1936
Cherries, washed in NaCl	Cts. 1200 to 600,000 present even after 3rd. washing	Hoder	1928
Blackberries		"	"
Currants		"	"
Yellow Plums		"	"
Pears		"	"
Damson plums		"	"
Fruits, moist	>15 d.	Mills	1925
Fruits, decayed portion	7-42 d.	"	"
Cider, -10C	31 wk.	MacFarlane	1940
Raspberries, -20C	26 wk.	"	"
Strawberries, -6.6C	Start 1900, Recov. 280, 6 wk.	Prescott	1932
" -12C	Start 1900, Recov. 960, 6 wk.	"	"
" -18C	Start 1900, Recov. 2200, 6 wk.	"	"

TABLE E7 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN FOOD (GENERAL)

Factor(s)	Survival	Reference	
FRUITS (cont'd)			
Raspberries, -6.6C	Start 50500, Recov. 275, 6 wk.	Prescott	1932
" -12C	Start 50500, Recov. 638, 6 wk.	"	"
" -18C	Start 50500, Recov. 1520 6 wk.	"	"
Orange juice, -6.6C	Start 2410, Recov. 1100, 20 d.	"	"
" " -12C	Start 2410, Recov. 1090, 20 d.	"	"
" " -18C	Start 2410, Recov. 1160 20 d.	"	"
Fresh strawberries, 15F	Inoc. fungi, yeast, bact., 1-3 yr.	Smart	1934
Strawberries in sealed tins	3 yr.	"	"
Fruits, -9.4C	>3 yr.	"	1935
Blueberries, frozen	Inoc. before freezing >100,000/gm., Recov. ≤1%, 7 mo.	"	1937
" in 50% sugar syrup, -6.7C	99.9% reduct., 9 mo.	"	1939
Blueberries, in 50% " syrup, -17.8C	60% " " "	"	"
Blackberries packed in 40% B. syrup	More recovered at -20C than -10C	Weiser	1951
CEREAL			
Soy beans, alfalfa	Viable 6-9 mo.	Fellers	1919
Pop corn, unpopped	Contained 100,000/g.	Breazeale	1951
" " popped	" 10/g.		
GENERAL			
Frozen foods	Fats and sugar soln. protect and acids destroy	James	1933
Food, -25.2C	> 10 hr.	Tanner	1944
Food, pH 2	Practically all destroi-ed	Virtanen	1940

TABLE E8 THE SURVIVAL OF MYCOBACTERIUM TUBERCULOSIS IN FOOD

Factor(s)	Survival	Reference	
MILK			
<u>Human</u>			
Milk	10 d.	Heim	1889
Sour milk	4 wk.	Honda	1938
Milk, 58C, pH 6.7, 6.3, 6.0	30 min.	Katrandjieff	1929
Milk, 60C-63C, pH 6.7, 6.3, 6.0	" "	"	"
Sour milk, 200cc., R.T., pH 4-5	Inoc. 1 loop cult., viable 7 d.	Kliewe	1937
Cream, 60C-80C	2 min.	Mohler	-
Milk, frozen, -8C to -20C	2 yr.	McCallum	1934
Ster. milk, 30C	Inoc. 500-2000/ml., 20 d.	Mattick	1946
Raw cream	Recov. 16 out of 31 samples	Pullinger	1935
<u>Bovine</u>			
Sour milk	10 d.	Honda	1938
Sour milk, 200cc., R. T.	Inoc. 1 loop cult., viable 20 d.	Kliewe	1937
DAIRY PRODUCTS			
<u>Human</u>			
Butter, 15-22C	30 d.	~~Hum~~ Heim	1889
Curds, " "	2 d.	"	"
Whey, " "	14 d.	"	"
Cheese, " "	" "	"	"
"	2 mo. (summer)	Kankaapaa	
"	140 d.	Kastli	1948
Emmenthal and Gruyere cheese	Inoc. >1/cc, 20-30 d.	"	1949
Munster and Camembert cheese	Inoc. " 47 d.	"	"
Tilsit cheese	" " 232 d.	"	"
Cheese with low fat milk	" " 326 d.	"	"
White cheese	>14 d.	Loncin	1950
Butter of milk held at 145F for 30 min.	Present	Smith	1932
Ice cream	$6\frac{1}{2}$ yr.	Wallace	1938
" "	30 mo.	"	1933
Butter from t.b. milk, pasteurized at 55, 60, and 70C	Survived pasteurization	Cookson	1926
<u>Bovine</u>			
Ice cream	$6\frac{1}{2}$ yr.	Wallace	1938
" "	30 mo.	"	1933
<u>Avium</u>			
Ice cream	$4\frac{1}{2}$ yr.	"	1938
" "	30 mo.	"	1933

TABLE E9 THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
S. paratyphi A			
Milk, ice box	170 d.	Barry	1927
Milk, 37C, 1 lactic acid to 250 milk	Inoc:1 loop 24 hr. cult; Recov:0;72-60 hr.	Kaiser	1921
Raw milk, 18C, pH 5.04-4.84	11 d.	Kliewe	1935
S. paratyphi B			
Milk, 37C, 1 lactic acid to 250 milk	Inoc:1 loop of 24 hr. cult; Recov:0; 12-60 hr	Kaiser	1921
Milk, 37C, 1 lactic acid to 500 milk	Inoc: 1 loop 24 hr. cult; Recov:0; 72 hr.	"	"
Milk, 37C, 1 lactic acid to 1200 milk	Inoc:1 loop 24 hr. cult; Recov:0; 60 hr.	"	"
Milk, ice box temp.	324 d.	Barry	1927
Raw milk, 18C, pH 5.04-4.84	11 d.	Kliewe	1935
Milk, pH 4.2	Growth checked	Palladina	1935
Milk, 5% NaCl, pH 4.6	24 hr.	"	"
Milk, pH 4.7-5.1	63 d.	Wilson	1945
S. paratyphi			
Ster. milk, 17-20% acid, 37C	Recov:0; 1-2 wk.	Kliewe	1935
Ster. milk, 24.13%, 20C	Viable 29 d.	"	"
" " 18.50%, 37C	Recov:0; 9 d.	"	"
" " 2.6-15.0%, 20C	" " 14 d.	"	"
" " 20.6%, 8C	" " 36 "	"	"
" " 33%, 20C	Viable 4-5 wks.	"	"
" " 26%, 8C	6-7 wk.	"	"
Raw milk, 27.04%, 37C	Recov.0; 14 d.	"	"
" " 33.25%, "	" " 4 d.	"	"
" " 27.36-18.3%,37C	" " 12 d.	"	"
" " 31.51%, 20C	" " 13 d.	"	"
" " 17.82%, "	" " 7 d.	"	"
" " 20.15%, "	" " 3 "	"	"
" " 22.61%, "	" " 7 "	"	"
" " 22.80%, 8C	" " 14 d.	"	"
Sour milk, pH 5.04-4.84	11 d.	"	"
Milk, R.T., acidity .7	4 d.	Marsh	1918
" suspn, 63C, in an open reagent glass	15 min.	Orskov	1925
Milk suspn, 63C, in water bath in glass with rubber stopper	Recov: 0; 3 min.	"	"
Milk suspn, 63C, warmed at 48C until a 1.5cm. ring of dried milk forms	" " 50 min.	"	"
Milk, pH 4.8	63 d.	Wilson	1945
S. enteritidis			
Milk, ice box temp.	180 d.	Barry	1927
Evapor. milk; 37C, 6-9C, 20C; pH 5.2, 7.2, 5.4	7 d.	Koser	1922

TABLE F9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference
MILK (cont'd)		
S. typhimurium		
Ster. milk, 22.28%, 20C	Viable 32 d.	Kliewe 1935
" " 16.50%, 37C	Recov: 0; 13 d.	" "
" " 24.13%, 8C	" " 47 d.	" "
" " 33%, 20C	Viable 4-5 wk.	" "
" " 25%, 8C	6-7 wk.	" "
Raw milk, 12.15%, 37C	Recov: 0; 14 d.	" "
" " 33.20%, "	" " 4 d.	" "
" " 25.77%, "	" " 13 d.	" "
" " 35.22%, 20C	" " "	" "
" " 25.05%, "	" " 10 d.	" "
" " 25.54%, "	" " 6 d.	" "
Milk, pH 4.2	Growth checked	Palladina 1935
" , 5% NaCl, pH 4.6	24 hr.	" "
Sour milk, 9.75-13% acid, 8C	Recov: 0; 11 d.	Kliewe 1935
S. typhosa		
Raw milk, 0.27% acid	5 d.	Bassenge 1903
" " 0.36% "	6 d.	" "
" " 0.63% "	24 hr.	" "
Milk	Recov: 0; 2 hr.	Belin 1933
" , ice box and R.T.	(Miss.) 290 d. and 187 d	Berry 1927
Sour milk, 1 d. old	Inoc:100cc+ cc½typhoid 1 mo.	Bolley 1898
" " 2 " "	Inoc:15cc+5cc; 5 d.	" "
" skim milk	" 100cc+½cc cult;5d.	" "
Sweet milk	" " + 24 hr. cult; 1 mo.	" "
Past. milk	Inoc:100cc,⅕cc cult;10d	" "
Whole ster. milk	" loop; 1 mo.	" "
Sweet cream	" 200cc,8cc cult; 4 mo	" "
Milk ster. by discount past., loop inoc.	Loop inoc; 4 mo.	" "
Milk, 56C for 20 min.	" " "	" "
Fresh milk drawn in ster. tube	" " 3 mo.	" "
Cream, freezing	Inoc:5cc of cult; >4 d.	Bolten 1918
Sour cream strongly acid	" 1 loop cult; 10 d.	Bruck 1903
Milk	" 1 g.; several days	Cautley 1897
Sour milk, R.T., 2.25% acid	6-8 d.	Demme 1925
Milk, 13-18C	Viable <48 d.	Heim 1889
Ster. milk	4 mo.	Hesse 1889
Milk, alternate freezing	Reduction <93-99%	Hillard 1918
Ster. milk, 17-20% acid, 37C	Recov:0; 4 hr.	Kliewe 1935
Ster. milk, 30% acid,8-20C	Recov. 0; several wk.	" "
" " , 25 min. in autocl, 5.25% acid	Viable 13 d.	" "
Ster. milk, 8.80-7.50% acid, 20C	" 14 d.	" "
Ster. milk, 23.88%, 20C	" 28 d.	" "
" " 23%-20.5%,37C	Recov. 0; 24 hr.	" "

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK (cont'd)			
S. typhosa			
Ster. milk, 25.85% acid, 8C	Recov. 0, 44 d.	Kliewe	1935
Ster. milk, 33% acid, 20C	Viable 2 wk.	"	"
" " 26% " 8C	Recov. 0, 6 wk.	"	"
Raw milk, 37C	" " 3 d.	"	"
" " " , 14.97% acid	" " 12 d.	"	"
" " " 33.73% "	" " 4 d.	"	"
" " " 17.81% "	" " 11 d.	"	"
" " 20C, 38.25% "	" " 12 d.	"	"
" " " 31.51% "	" " 6 d.	"	"
" " " 24.45% "	" " 3 d.	"	"
Sour raw milk, 20C, 9.75-16.50% acid	" " 3 d.	"	"
Raw milk, 8C, 20.38-22.35% acid	" " 12 d.	"	"
Raw milk, 8C, 18.75-20.90% acid	" " 14 d.	"	"
Raw milk, 18C, pH 7.17-6.94	Inoc. 2 loops, Recov. 0, 48 hr.	"	"
Raw milk, 37C, pH 5.02-3.56	Inoc. 2 loops, Recov. 0, 24 hr.	"	"
Raw milk, 1 loop B. coli, 18C, pH 3.94-7.93	Inoc. 1 loop, " " 12 d.	"	"
Raw milk, 37C	3 d.	Kredba	1935
Sour cream, R.T.	Inoc. 7 million, Recov. 0 48 hr.	Krumwiede	1914
Cream, soured overnite in sterilizer	Inoc. 7 million, " " 120 hr.	"	"
Cream, R.T.	Inoc. 375,000, Recov. 0, 96 hr.	"	"
Milk, 66C-74C	Recov. 0, 1 d.	Lazarus	1890
Milk, R.T, acid .7	5 d.	Marsh	1918
Fresh milk, acid 19-1.4	1-2 d.	"	"
Sour milk	3 mo.	Osler	1901
Milk, pH 4.2	Growth was checked	Palladina	1935
Fresh milk, 7-10C	Inoc. suspn. of agar, viable 11-13 d.	Pfuhl	1902
Milk, 3C	2 d.	Seitz	1886
Milk, 0.71% acid	8 d.	Wade	1928
" 0.53% "	30 d.	"	"
" with S. lacticus, 0.84% acid, R.T., and 0.65%, ice box temp.	5 d. and 27 d.	"	"
Milk, with diplococcus "x", 0.88% acid, ice box	86 d.	"	"
Milk, with diplococcus "x", 1.04% acid, R.T.	34 d.	"	"
Milk, 0.90% acid	1 d.	"	"
Milk, 0.74, 0.78, 0.81%	4 d.	"	"
Milk	20 d.	Washburn	1908
" , pH 4.9-5.1	63 d. plus	Wilson	1945

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY PRODUCTS			
S. paratyphi A			
Butter	117 d.	Berry	1927
S. paratyphi B			
Butter	212 d.	"	"
Milk curds	48-96 hr.	Bhat	1949
Yoghurt, 1.87% acid	Inoc. 1 loop 24 hr. cult Recov.0, 48-108 hr.	Kaiser	1921
" 0.29%-0.82% acid	Inoc. 1 loop 24 hr. cult Recov. 0, 12 hr.	"	"
" 1.89%-2.14% "	Inoc. 1 loop 24 hr. cult Recov. 0, 60-72 hr.	"	"
" 2.35% acid	Inoc. 1 loop 24 hr. cult Recov. 0, 120 hr.	"	"
" 1.07% "	Inoc. 1 loop 24 hr. cult Recov. 0, 24 hr.	"	"
Butter and margarine, rapid develop. of acid and prompt salting	Growth checked	Palladina	1935
Buttermilk	15 d.	Stever	1941
S. paratyphi types			
Milk curds	48-96 hr.	Bhat	1949
Butter (English), 15C	≤112 d.	Pullinger	1938
" " 30C	≥112 d.	"	"
Buttermilk	15 d.	Stever	1941
Cheese	Most common	Fabian	1947
S. sp. (Type Newport)			
Butter, contamined by cooling water	Present ---	Eriksson	1941
S. enteritidis			
Butter	228 d.	Berry	1927
Milk curds	48-96 hr.	Bhat	1949
Butter (English), 15C	≤112 d.	Pullinger	1938
" " 30C	≥112 d.	"	"
Ice cream, -23.2C	7 yr.	Wallace	1938
" " freezing	30 mo. +	"	1933
S.typhimurium			
Butter	239 d.	Berry	1927
Ice cream	98 d.	Glass	1946
Butter and margarine, rapid develop. of acid and prompt salting	Growth checked	Palladina	1935
Cheese, 43-48F	Inoc. colby cheese, 302d.	Tucker	1946
Ice cream, -23.2C	6 yr.	Wallace	1938
" " freezing	30 mo. +	"	"
S. choleraesuis			
Butter	49 d.	Berry	1927
S. typhosa			
Buttermilk, strongly acid	Inoc. 1 loop cult, 10 d.	Bruck	1903
" 22C	" 2 " 24 hr. cult 3 d.	Fraenkel	1898
" 37C	Inoc. 2 loop 24 hr. cult 24 hr.	"	"
" pH 3.5-4.4	2-3 d.	Marsh	1918

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY PRODUCTS (cont'd)			
S. typhosa			
Buttermilk, pH 3.1-4.5	1 d.	Marsh	1918
" R.T.	3 d.	Rubenstein	1902
" incubator	24 hr.	"	"
Cheese infected by water	6-10 mo.	Anon.	1944
Butter	22 d.	Berry	1927
"	110 d.	"	"
Milk curds	48-96 hr.	Bhat	1949
Fresh creamery butter	Inoc. spots, 5 d.	Bolley	1898
" " "	" germs mixed, 5 d.	"	"
" " "	" 1 loop, 5 d.	"	"
" " " , salt 4 oz./lb.	" " " "	"	"
Unsalted churned butter	" 200cc&8cc cult, 10 d.	"	"
Salted churned butter, 10 oz./lb.	Inoc. 200cc & 8cc cult, 10 d.	"	"
Fresh creamery butter, kept in cold storage	None found	"	"
Fresh creamery butter salted, in cold storage	" "	"	"
Cheese	80 d.	Bowman	1942
Butter, strongly acid	Inoc. 1 loop cult, 27 d.	Bruck	1903
Cheese, 58-60F	3 mo.	Campbell	1944
" 40-42F	6-10 mo.	"	"
" cheddar	≤3 mo.	Foley	1945
Butter, 13-18C	Viable 21 d.- 1 mo.	Heim	1889
Cheese, 35C, alkaline	" 3 d.	"	"
White cheese, 35C	" ≤24 hr.	"	"
Curds, 35C	" 1 d.	"	"
Whey	" 1 d.	"	"
Cheese	4 wk.	Hesse	1889
Butter, weakly acid	4-5 d.	Laser	1891
Butter	6 d.	Lafar	-
Cheese, 60F, artifically infected	34-36 d.	Meyer	1944
Ice cream, frozen	Inoc. 70,000/cc, Recov. 450,000/cc in 24 hr.	Mitchell	1915
" " " Knox gelatin added	Inoc. 400,000/cc, Recov. 60,000/cc in 24 hr.	"	"
Butter made from infected cream	Several days	Osler	1901
Butter and margarine, rapid develop. of acid and prompt salting	Growth checked	Palladina	1935
Fresh butter, 7-10C	Inoc. agar cult. ground in agar mortar, 24 d.	Pfuhl	1902
Gervais cheese	Inoc. agar cult, "	"	"
Ice cream	≥2 yr.	Prucha	1926
All classes of butter	At least 80 d.	Pullinger	1938
Sweet and sour curds, pH 4.2-4.7	Inoc. 4 drops cult, Recov 0, ≤1 hr.	Panja	1945

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY PRODUCTS (cont'd)			
S. typhosa			
Cheese, R.T.	26 d.	Ranta	1941
" ice box	-75 d.	"	"
Ice cream, -19C	1 yr.	Tanner	1928
Colby cheese	45 d.	Thomasson	1944
Cheddar cheese, from contaminated milk, 1.04% acidity	36 d.	Wade	1928
Cheddar cheese (commercial)	63 d.	"	"
Cheese, 1.12% acid, exposed to air	16 d.	"	"
Cheese, 0.94% acid, exposed to air	13 d.	"	"
Cheese, 0.97% acid, exposed to air	"	"	"
Cheese, 0.98% acid, no air	7 d.	"	"
EGGS			
S. typhimurium			
Defrosted whole egg; -1, -9, and -18C	11 mo. +	Hartsell	1950
S. typhosa			
Defrosted whole egg	" " "	"	"
S. sp. (Type Oranienburg)			
Defrosted whole egg; -1, -9, and -18C	" " "	"	"
S. spp.			
Fermented albumen, R.T., dried	Recov. 100%	Ayres	1949
Fermented " 120F, dried	20 d.	"	"
Eggs	0.6% of samples	Felsenfield	1950
" powdered	3% " "	"	"
Spray dried eggs	Recov. in 9.9% of samples	Med. Res. Coun.	1947
Duck eggs	Present	Mallam	1946
Powdered egg, 35F	65 wk.	Wilson	1948
S. pullorum			
Raw egg	Inoc. feces, present	Mitchell	1946
MEAT			
S. paratyphi B			
Chicken chow mein, -25.5C	Inoc. 230×10^5/gm, Recov. 19×10^5/gm, 270 d.	Gunderson	1948
S. paratyphi types			
Livers, brains, hamburger steak, fresh pork, sausage, pork and beef loaf, kidney, cooked pork, smoked sausage cured ham and bacon, beef, lamb, calf sweetbreads, and chicken livers	Present	Cherry	1942

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MEAT (cont'd)			
S. paratyphi types			
Beef	1 of sample	Felsenfield	1950
Birds (inspected)	0.9% of samples	"	"
" (uninspected)	10.8% of "	"	"
Pork (inspected)	14.3% of "	"	"
" (uninspected)	26.8% " "	"	"
Hamburger	17.6% " "	"	"
S. enteritidis			
Corned beef	Inoc. 30-5000/gm, Recov. 30x10^6, ➡ 60 d.	Surgella	1945
S. typhimurium			
Chicken chow mein, -25.5C	Inoc. 167x10^5/gm, Recov. 34x10^5/gm, 270 d.	Gunderson	1948
S. anatum			
Chicken chow mein, -25.5C	Inoc. 100x10^5/gm, Recov. 4.2x10^5/gm, 270 d.	"	"
S. gallinarum			
Chicken chow mein, -25.5C	Inoc. 68.5x10^5/gm, Recov. 4.8x10^5/gm, 270 d.	"	"
S. sp. (Type Newington)			
Chicken chow mein, 25.5C	Inoc. 75.5x10^5/gm, Recov. 2.2x10^5/gm, 270 d.	"	"
S. typhosa			
Souse meat	3 mo.	Duff	1942
Salt fish blocks, 5-6C	22 d.	Frank	1941
Chicken chow mein, -25.5C	Inoc. 12.8x10^5/gm, Recov. 4.8x10^5/gm, 270 d.	Gunderson	1948
Oysters	10 d.	Herdman	1899
Shell oysters, 5-8C, floated 1 hr. in sea water to which typhoid is added	3 strains 21-24 d.	Jordan	1925
Oysters, 10C and -2.8 to 14.4C	15 d.	Kinyoun	1925
Oysters, wet	Inoc. 160,000,000, Recov 320, 4 d.	Klien	1905
" dry	Inoc. 160,000,000; " 1220, 7 d.	"	"
" wet, infected water	Inoc. 744,000/cc; " 44; 6 d,	"	"
Oysters, dry, infected by water	Inoc. 744,000/cc; Recov 90- 9 d.	"	"
Oysters, sterile sea water, wet	Inoc. 2,250,000; Recov. 105; 3 d.	"	"
Oysters, sterile sea water, dry	Inoc. 2,250000; Recov. 714; 4 d.	"	"
Cockles in sea water	Inoc. 4 million/cc	"	"
Mussels " " "	" 5,170,000/cc	"	"
Oysters	7-11 d.	"	"
Sausage, 4 d. drying	13 d.	Mueller-Claus	1938

TABLE *E9* (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MEAT (cont'd)			
S. typhosa			
Sausage, 35C	24 hr.	Maurel	1910
Tuna, -3 to 22.5C	Inoc. 3371 g, Recov. 0, 39 d.	Tetsumoto	1930
Mackeral, -3 to 22.5C	Inoc. 3435 g, " " 38 d.	"	"
Cuttle fish, -3 to 22.5C	Inoc. 3399 g, " " 40 d.	"	"
Oyster, -3 to 22.5C	Inoc. 3262 g, " " 45 d.	"	"
Sea cucumber, -3 to 22.5C	Inoc. 3413 g, " " 31 d.	"	"
Tuna, 22.5 - 31C	Inoc. 3498 g, " " 22 d.	"	"
Mackeral, 22.5 - 31C	Inoc. 3391 g, " " 20 d.	"	"
Cuttle fish, 22.5 - 31C	Inoc. 3444 g, " " 22 d.	"	"
Oyster, 22.5 - 31 C	Inoc. 3365 g, " " 24 d.	"	"
Sea cucumber, 22.5 - 31C	Inoc. 3415 g, " " 20 d.	"	"
Shucked oysters, 98F	Inoc. 74,000,000/cc; Recov. 0, 1 d.	Tonney	1925
" " 70F	Inoc. 74,000,000/cc; Recov. 0, 4 d.	"	"
" " 45 F	Inoc. 74,000,000/cc; Recov. 0, 22 d.	"	"
Shell fish	---	T & W	1946
SAUCES			
S. spp.			
Salad dressing, 37C, pH 3.8, 0.48% acid	12 hr.	Wethington	1950
Mayonnaise, 37C, pH 3.2, 1.10% acid	6 hr.	"	"
Mayonnaise, with egg yolk, 0.51% acid, pH 4.0 fresh	18 hr.	"	"
Mayonnaise, with egg yolk, 0.51% acid, pH 4.0, emulsol	12 hr.	"	"
Salad dressing, with egg yolk, 1.20% acid, pH 3.30, fresh	8 hr.	"	"
Salad dressing, with egg yolk, 1.20% acid, pH 3.30, emulsol	1 hr.	"	"
Salad dressing, pH 4.4, 0.4% acid	144 hr.	"	"
Mayonnaise, pH 5.0, 015% acid	144 hr.	"	"

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
CEREAL			
S. sp.			
Crust of rye bread, R.T.	6 mo.	Bachmann	1943
S. typhosa			
Bread, after baking, R.T.	3 hr. (same results when smeared with fecal suspn.)	Alves	1935
Crust of rye bread, R.T.	4½ mo.	Bachmann	1943
VEGETABLES			
S. enteritidis			
Corn and spinach	3 yr.	Doyle	1930
Canned peas	200 d.	"	"
Spinach, 20C and 6-9C	7 d.	Koser	1922
String beans, 20C and 6-9C	7 d.	"	"
Corn, pH 6.2-6.0, 20C and 6-9C	7 d.	"	"
Peas, pH 5.8-6.0, 20C and 6-9C and 37C	7 d.	"	"
S. typhimurium			
Canned spinach	3 yr.	Doyle	1930
Corn, R.T.	Inoc. 700,000/cc; 100 d.	"	"
Canned peas	200 d.	"	"
Green veg., R.T.	3-7 wk.	Felsenfield	1945
" " refrigerator	5-11 wk.	"	"
Peas, -9C, sharp frozen	Inoc. 14.55; Recov. 0, 9 wk.	Hartsell	1951
S. pullorum			
Green veg., R.T.	4-8 wk.	Felsenfield	1945
Onions	Not considerable time	"	"
S. sp. (Type Oranienburg)			
Green veg., R. T.	2-7 wk.	"	"
" " refrigerator	5-10 wk.	"	"
Peas, -9C, sharp frozen at -25C	Inoc. 28.45x, Recov. 0, 0.273x, 12 wk.	Hartsell	1951
S. sp. (Type Montevided)			
Green veg., refrigerator	5-10 wk.	Felsenfield	1945
" " R.T.	2-7 wk.	"	"
S. typhosa			
Green washed herbs	Several days	Anon.	1923
Lettuce saldd, washed at 1-6-12 hr. after infected with typhoid	As many at 12 hr. as at one	Ceredi	1929
Green veg., R.T.	25 d.	Creel	1912
" " exposed to rain and sun part of day	31 d.	"	"
Green veg., exposed all day	10 d.	"	"
Peas, -9C, sharp frozen at -25C	Inoc. 33.4×10^6; Recov. 0.124×10^6; 12 wk.	Hartsell	1951

TABLE E9 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
VEGETABLES (cont'd)			
<u>S. typhosa</u>			
Mushrooms	4-5 wk.	Hesse	1889
Plants	3-5 d.	Lominsky	1890
Radishes, grown in contaminated soil	>37 d.	Melick	1917
Lettuce, grown in contaminated soil	>21 d.	"	"
Cabbage, 80C, water	10 sec.	Ommyoji	1931
Carrots, 80C, shaken in water	5 sec.	"	"
Soy bean sauce, pH acid, 25-17C	Inoc. 1 loop, >24 hr.	Wang	1945
Soy bean sauce, pH " 36-38C	" " " <24 hr.	"	"
FRUITS			
<u>S. paratyphi B</u>			
Watermelon	120 hr.	Bhat	1948
Sliced sweet strawberries -18C	1 mo.	McCleskey	1941
Cherries, -17.8 and -40C	2-3 mo.	Wallace	1933
Cherry juice, -17.8 and -40C	4 wk.	"	"
<u>S. paratyphi types</u>			
Orange juice, -4C	170 hr.	Beard	1932
Sliced sweet strawberries -18C	Not recovered	McCleskey	1941
Orange juice, -4C, pH 3.5	96 hr.	Beard	1932
<u>S. enteritidis</u>			
Tomatoes, 20C and 6-9C	7 d.	Koser	1922
<u>S. typhimurium</u>			
Sliced sweet strawberries -18C	Inoc. 500/gm., 6 mo.	McCleskey	1941
Cherries, -17.8 and -40C	2-3 mo.	Wallace	1933
Cherry juice, -17.8 and -40C	4 wk.	"	"
<u>S. typhosa</u>			
Sliced sweetened strawberries, -18C	Inoc. 500/gm., 6 mo.	McCleskey	1941
Uncut sweet strawberries	14 mo.	"	"
Pears, >80C, water	>1 min.	Ommyoji	1931
Surface of dates	68 d.	Smeall	1932
Cherry juice, -14C	Inoc. artificial, 2 wk.	Tanner	1931
" " -16C	" " 5 mo.	"	"
" " -17.8 and -40C	<4 wk.	Wallace	1933
Cherries, -17.8 and -40C	2-3 mo.	"	"
Orange juice, -4C, pH 3.5	170 hr.	Beard	1932
BEVERAGES			
<u>S. typhosa</u>			
Beer, 22-37C	1-3 d.	Humpesch	1949
" 5 C	38 d.	"	"
" with paratyphoid	5-10 wk.	"	"

TABLE *E9* (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
BEVERAGES (cont'd)			
S. typhosa			
Beer, 4.86% alcohol, 1.79% acid	4 d.	SerpaSantos	1939
Wines	1 hr.	"	"
S. spp.			
Beer, 22-37C, with paratyphoid	1-3 d.	Humpesch	1949
Beer, natural with paratyphoid	5-10 wk.	"	"
Carbon dioxide drinks	Effect of CO_2 greatest at 19-23C	Koser	1922
Red wine, 15C, 4.90% sulphuric acid	Inoc. 2 drops, 2 hr.	Sabrazes	1907
White wine, 17-18C, 5% acid	" " " 1 hr.	"	"
Cerons, 11-18C	" " " 5 min.	"	"
GENERAL			
S. sp.			
Anaerobic sludge used for fertilizer	7 d.	Wolman	1924

TABLE E10 THE SURVIVAL OF SHIGELLA SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
Sh. dysenteriae			
Fresh milk, 7-10C	18-27 d.	Pfuhl	1902
Milk, pH 4.8-4.9	53 d.	Wilson	1945
Sh. paradysenteriae (Flexner)			
Milk, pH 4.5-4.7	53 d.	"	"
Sh. paradysenteriae			
Sterile milk, 17-20C	Until it dries up	Frost	1905
Milk, R.T., acid 0.8	3 d.	Marsh	1918
MILK PRODUCTS			
Sh. dysenteriae			
Buttermilk	15 d.	Stever	1941
Butter	18 d.	Berry	1927
Curds	Do not survive	Bhat	1949
Fresh butter	Inoc. agar cult. ground in agar mortar	Pfuhl	1902
Gervais cheese	Inoc. agar cult., 9 d.	"	"
Sweet andsour milk curds, pH 4.2-4.7	Inoc. 4 drops of cult. Recov. 0, <4 hr.	Panja	1945
Sh. paradysenteriae			
Curds	Do not survive	Bhat	1949
Buttermilk	15 d.	Stever	1941
EGGS			
Sh. paradysenteriae			
Albumin balls, 17-20C	1 d. or 1 mo.	Frost	1905
Frozen eggs, -9C	3 mo.	Hartsell	1951
MEAT			
Sh. dysenteriae			
Bacon and sausage, R.T.	>3 wk.	Buchanan	1918
CEREALS			
Sh. dysenteriae			
Bread after baking, R.T.	30 hr.	Alves	1935
Crust of rye bread	20 d. alive	Bachmann	1943
" " " " R. T.	66 d. dead	"	"
Bread, rice, 17-20C	1 d. or 1 mo.	Frost	1905
" R.T.	11 d.	Stanley	1930
Sh. paradysenteriae (Flexner)			
Bread after baking, R. T.	30 hr.	Alves	1935
Crust of rye bread	23 d. alive	Bachmann	1943
" " " " -5 to -25C	45 d.	"	"
Sh. paradysenteriae (Sonne)			
Crust of rye bread	Over grown with spores	"	"
VEGETABLES			
Sh. dysenteriae			
Soy bean sauce, 25-17C	Inoc. 1 loop, >24 hr.	Wang	1945
" " " 36-38C	" " " <24 hr.	"	"
FRUITS			
Sh. dysenteriae			
Orange juice, -40C	170 hr.	Beard	1932
Sh. paradysenteriae (Sonne)			
Tomato surface	48 hr.	Johnston	1935

TABLE E10 (CONT'D) THE SURVIVAL OF SHIGELLA SPECIES IN FOOD

Factor(s)	Survival	Reference
FRUITS (cont'd)		
Sh. paradysenteriae (Sonne)		
Tomato tissue	10 d.	Johnston 1935
"	Inoc. artificial, 6 d.	" "
Apple	" " 8 d.	" "

TABLE *E11* THE SURVIVAL OF STREPTOCOCCUS SPECIES IN FOOD

Factor(s)	Survival	Reference	
MILK			
Streptococcus cremoris			
Sterilized milk, 30C	2 d.	Mattick	1946
Streptococcus fecalis			
Milk, 62.8 and 37C	Young cells more resistant than mature	Stark	1929
Streptococcus spp.			
Milk, 110C	Recov. 4 hr.	Belin	1933
Milk, ice box	17 d.	Berry	1927
Sour milk, 30C	48 hr.	Davis	1914
Dried milk	The lower the humidity the longer the survival	Watts	1945
Cultures 55:			
Milk of resistant cow	Inoc. 6336, Recov. 9185, 8 hr.	McCullough	1945
Boiled milk of resistant cow	Inoc. 7260, Recov.> 20160 8 hr.	"	"
Milk of young cow early in first lactation period	Inoc. 5356, Recov. 22464 8 hr.	"	"
Boiled milk of same cow	Inoc. 5068, Recov> 36992 8 hr.	"	"
Freshly isolated strains:			
Milk of resistant cow	Inoc 7168, Recov. 41320 8 hr.	"	"
Boiled milk of resistant cow	Inoc. 7296, " > 16588 8 hr.	"	"
Raw milk of young cow early in first lactation	Inoc. 1344, Recov. 19120 8 hr.	"	"
Boiled milk of same cow	Inoc. 1197, Recov.> 30538 8 hr.	"	"
DAIRY PRODUCTS			
Streptococcus pyogenes			
Butter	17 d.	Berry	1927
Limburger cheese, moisture content 42.8	28-51 d.	Yale	1940
Limburger cheese, moisture content 49.3	9-14 d.	"	"
Cheddar cheese, cured at 45F	> 18 wk.	"	"
Cottage cheese, low temp.	Not recovered	"	"
Streptococcus fecalis			
Cheddar cheese, 50F	Inoc. 300/ml, Recov. 11x 10^6 /ml, 180 d.	Kosikowsky	1948
" " 60F	Inoc. 300/ml, Recov. 13x 10^6/ml, 180 d.	"	"
Streptococcus spp.			
Butter, from infected cow, salted	6 mo.	Bryan	1944
Butter, from infected cow, unsalted	6 mo.	"	"

TABLE E11 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN FOOD

Factor(s)	Survival	Reference	
DAIRY PRODUCTS (cont'd)			
Streptococcus spp.			
Ice cream	18 d.	Davis	1914
" " at 20C	No growth	"	"
" " " 26C	Growth in 20 hr.	"	"
" " refrigerator	Inoc. 45, Recov. 12 hr. 34,695 org.	Pennington	1907
" " R. T.	Inoc. 70, Recov. 34,491, 12 hr.	"	"
" " incubator	Inoc. 18, Recov. 85844.4, 12 hr.	"	"
EGGS			
Streptococcus spp.			
Egg white, 50C	Recov. 6, 4 hr.	Belin	1933
MEAT			
Streptococcus pyogenes			
Sausage, 4 d. drying	13 d.	Mueller-Claus	1938
Lobster meat	May remain alive in salad a considerable time	Scamman	1927
Streptococcus viridans			
Potted meat	Inoc. 30-5000/gm. meat, Recov. 30x10^{6} org, 60d.	Surgella	1945
VEGETABLES			
Streptococcus fecalis			
Veg., -20C	Recov. 89% out of 70 in 1 yr.	Burton	1949

TABLE E121 THE SURVIVAL OF VIBRIO SPECIES IN FOOD

Factor(s)	Survival	Reference
MILK		
Vibrio comma		
Milk, R.T.	11-63 hr.	Alessandrini -
" 37C	6-8-hr.	"
" boiled and uncovered	5-8 d.	"
Sour milk and cream	Lethal effect	Grattan 1939
Milk, 7-22C	6 d.	Heim 1889
Sterile milk, 22C	6-9 hr.	Lazarus 1890
" " 35C	12-24 hr.	" "
" " 62-70C	1 d.	" "
DAIRY PRODUCTS		
Vibrio comma		
Curds	Do not survive	Bhat 1949
Cheese	8-15 hr.	Genevray 1938
Butter, R.T.	21 d.	Grattan 1939
" 37.5C	32 d.	Heim 1889
Curds, 35C, weakly acid	0 d.	" "
Whey, 35C, " "	2 d.	" "
Cheese, 35C	1 d.	" "
Cheese	4-5 wk.	Hesse 1889
Butter (English), 15C	>38 d.	Pullinger 1938
" " 3C	>98 d.	" "
Sweet and sour curds, pH 4.2-4.7	Inoc. 4 drops cult., Recov. 0, 5 min.	Panja 1945
EGGS		
Vibrio comma		
Salted salmon eggs, 23-33C	Inoc. 0.1cc., Recov. 0, 2 d.	Tetsumoto 1930
Grey mullet eggs, 23-33C	Inoc. 0.1cc., " " 3 d.	" "
Cod eggs, 23-33C	Inoc. 0.1cc., Recov. 0, >8 d.	" "
Salted sea-urchin eggs, 23-33C	Inoc. 0.1cc., Recov. 0, 12 hr.	" "
MEAT		
Vibrio comma		
Fish cooked in acid	4 d.	Arguelles 1927
" boiled in salt water	6 d.	" "
" washings	<1 d.	" "
Sterile fish washings	6 d.	" "
" " extract	125 d.	" "
Salted fish cooked	1 d.	" "
" " uncooked	<1 d.	" "
Uncooked small srimp	6 d.	" "
Cooked " "	4 d.	" "
Fresh cattle, blood sausage, ham broth	45 wk.	Hesse 1889
Meat	Well	Lal 1926
Fat	Poor	" "
Salmon skin 22.5-33C	18 hr.	Tetsumoto 1930
" ventral, 22.5-33C	18 hr.	" "
" flesh, 22.5-33C	18 hr.	" "

TABLE F121 (CONT'D) THE SURVIVAL OF VIBRIO SPECIES IN FOOD

Factor(s)	Survival	Reference	
MEAT (cont'd)			
Vibrio comma			
Salmon skin (ster.), 23-33C	26 hr.	Tetsumoto	1930
Salmon ventral flesh (ster) 22.5-33C	19 hr.	"	"
Salmon flesh (ster.), 22.5-33C	20 hr.	"	"
Trout skin, 22.5-33C	26 hr.	"	"
" ventral flesh, 22.5-33C	18 hr.	"	"
Trout flesh, 22.5-33C	18 hr.	"	"
" skin (ster.), 22.5-33C	25 hr.	"	"
Trout flesh (ster.), 22.5-33C	18 hr.	"	"
Aramahi salmon skin, 22.5-33C	38 hr.	"	"
Aramahi salmon flesh, 22.5-33C	26 hr.	"	"
Cod, 22.5-33C	8 hr.	"	"
Ham, " "	26 hr.	"	"
Yellow fish skin, 22.4-33C	27 hr.	"	"
Yellow fish flesh, 22.5-33C	27 hr.	"	"
Mackeral skin, 22.5-33C	27 hr.	"	"
" flesh, " "	25 hr.	"	"
" pike, " "	26 hr.	"	"
Sardine, 22.5-33C	25 hr.	"	"
Sea bream skin, 22.5-33C	38 hr.	"	"
" " flesh, " "	32 hr.	"	"
Horse mackeral, " "	38 hr.	"	"
Flying fish	38 hr.	"	"
Bacon	40 hr.	"	"
Tuna	2 d.	"	"
Sword fish	3 d.	"	"
Trout	2 d.	"	"
Shrimp	3 d.	"	"
Salted cod, 16-27.5C	Recov. 0, 12 hr.	"	"
" salmon, 16-27.5C	" " 36 hr.	"	"
Aramahi salmon flesh, 16-27.5C	" " 25-40 hr.	"	"
Mackeral, 16-27.5C	" " " " "	"	"
Sardine, " "	" " " " "	"	"
Flying fish	" " " " "	"	"
Sardine (oiled), 19-34.5C	Inoc. 0.1cc, Recov. 0, 33 d.	"	"
" (tomato), " "	Inoc. 0.1cc, Recov. 0, 31 d.	"	"
" (yamatoni), 19-34.5 C	Inoc. 0.1cc, Recov. 0, 20 d.	"	"

TABLE E/2 (CONT'D) THE SURVIVAL OF VIBRIO SPECIES IN FOOD

Factor(s)	Survival	Reference	
MEAT (cont'd)			
Vibrio comma			
Bointo (yamatoni), 19-35.5C	Inoc. 0.1cc, Recov. 0, 6 d.	Tetsumoto	1930
Salmon, 19-34.5C	Inoc. 0.1cc, Recov. 0, 27 d.	"	"
Whitebait, 19- 34.5 C	Inoc. 0.1cc, Recov. 0, 19 d.	"	"
Crab, 19-34.5C	Inoc. 0.1cc, Recov. 0, 18 d.	"	"
Shrimp, 19-34.5C	Inoc. 0.1cc, Recov. 0, 13 d.	"	"
Sea-ear, 19-34.5 C	Inoc. 0.1cc, Recov. 0, 25 d.	"	"
Scallop, " "	Inoc. 0.1cc, Recov. 0, 22 d.	"	"
Beef yamatoni, 19-34.5C	Inoc. 0.1cc, Recov. 0, 12 d.	"	"
Cuttle fish, 22.5-27.5C	Inoc. 0.1cc, Recov. 0, 5 hr.	"	"
Fukujinzuke, 19-34.5C	Inoc. 0.1cc, Recov. 0, 6 hr.	"	"
Control in saline, 19-34.5C	Inoc. 0.1cc, Recov. 0, 6 d.	"	"
Fish, 5C-13C, natural oysters and clams, 22C, ster. with steam	8 d. - 2 wk.	Tohyama	1925
Oysters and clams, 0-5C	40 d.	"	"
Fish meat, 80C	2 min.	"	"
" " 70C	3 min.	"	"
" " 60C	7.5 min.	"	"
" " hottest day	7-10 d.	"	"
" " 3-8C	2 wk.	"	"
SAUCES			
Vibrio comma			
Nudu-mam sauce	6 hr.	Genevray	1938
Srimp past	6 hr.	"	"
Fermented soy sauce	<1 hr.	"	"
Soy bean sauce, 25-17C	Inoc. 1 loop, Recov. 0, >24 hr.	Wang	1945
" " " 36-38C	Inoc. 1 loop, Recov. 0, <24 hr.	"	"
CEREAL			
Vibrio comma			
Soy bean milk	8-15 hr.	Genevray	1938
VEGETABLES			
Vibrio comma			
Potatoes	4-5 wk.	Hesse	1889
Veg.	Well	Lal	1926
FRUITS			
Vibrio comma			
Watermelon, pH 4.7	4 d.	Bharucha	1938

TABLE E12 (CONT'D) THE SURVIVAL OF VIBRIO SPECIES IN FOOD

Factor(s)	Survival	Reference
FRUITS (cont'd)		
Vibrio comma		
Watermelon	Inoc. artificial, 6 d.	Bharucha 1938
Grapes	4 d.	Dobrosklonsky 1911
Berries (inside)	24 hr.	" "
Grape stems	12 d.	" "
Grapes (inside)	24 hr.	" "
Fresh lime, pH 4.4	30 min.	Panja 1945
GENERAL		
Vibrio comma		
Human food	6 d.	Vasquet-Colet 1924
Vibrio sp.		
Skim milk, frozen, dried at 100m. press.	681 d.	Stockton 1950

TABLE E.3 THE SURVIVAL OF VIRUS IN FOOD

Factor(s)	Survival	Reference	
MILK			
Polio virus			
Milk	Polio virus can stand more heat in milk than water	Lawson	1947
Foot and mouth disease virus			
Milk	Present ---	Jansen	1942
DAIRY PRODUCTS			
Polio virus			
Butter, ice box	91 d.	Kling	1931
EGGS			
Newcastle disease virus			
Eggs, 36C, incubator	up to 126 d.	Olesiuk	1951
" R.T., 20-30C	" " 235 d.	"	"
" hen house, 36C	255 d.	"	"
" ice bow, 3-6C	538 d.	"	"
Foul-pox virus			
Chicken eggs, in dry state	Active at 3593 d.	Beaudette	1948
Duck eggs, " " "	" " 1928 d.	"	"
Pigeon-pox virus			
Chicken eggs, " " "	" " 3605 d.	"	"
Duck eggs, " " "	" " 1099 d.	"	"
Jap. B encephalitis virus			
Eggs, 4C	6 hr.	Morgan	1946
MEAT			
Foot and mouth disease virus			
Beef, -20C, thawed in buff. phosphate soln. at 37C	4 mo.	Henderson	1948
Beef, -4C	24 hr.	"	"
CEREAL			
Foot and mouth disease virus			
Chopped hay, R. T.	15 wk.	Anon.	1927
Bran, R. T.	20 wk.	"	"
Hay and bran, dried	15-20 wk.	Burbury	1928
Hay (saliva on it)	>1 mo.	Krueger	1942
N. d. virus			
Mash, pH 5.5, 37C	56 d.	Olesiuk	1951
" " " 20-30C	94 d.	"	"
" " " 11-36C	172 d.	"	"
" " " 3-6C and -26C	>538 d.	"	"
FRUITS			
Polio virus			
Unwashed fruits and veg.	Present ---	Gebhart	1946

TABLE E14 THE SURVIVAL OF YEAST AND MOLD IN FOOD

Factor(s)	Survival	Reference	
MILK			
Yeast			
Milk, -21 to -78C	Inoc. 100,000/ml., more resistant to freezing than thawing	Lund	-
DAIRY PRODUCTS			
Mold			
Margarine	Viable 42%	Foltz	1951
Yeast			
Margarine	" 46%	"	"
VEGETABLES			
Mold			
Veg., frozen	90% killed	Magoon	1932
" below freezing	16 mo.	Tanner	1931
Yeast			
Veg., frozen	90% killed	Magoon	1932
FRUITS			
Mold			
Fruit juices, -23.3C	3 yr.	Tanner	1934
Good oranges, 17.8C	Inoc. 10,900/cc, Recov. 2,600/cc, 7 mo.	Wolford	1948
Soft rotten oranges, 17,8C	Inoc. 26,500,000/cc, Recov. 990,000/cc,8 mo	"	"
Strawberries, -9.4C, sealed tins	3 yr.	Smart	1934
Yeast			
Good oranges, 17.8C	Inoc. 10,900/cc, Recov. 2,600/cc, 7 mo.	Wolford	1948
Soft rotten oranges, 17.8C	Inoc. 26,500,000/cc, Recov. 990,000/cc,8 mo	"	"
Grape juice, freezing	18 wk.	Tanner	1944
Strawberries, -9.4C, sealed tins	3 yr.	Smart	1934
BEVERAGES			
Yeast			
Beer, freezing	Cells remain active	Melsens	1870
Beer,	15 yr.	Tanner	1944
GENERAL			
Yeast			
Food, -9.4C	3-15 mo.	Smart	1936
Syrup, very dry condition isolated from acid syrup	Several wk.	Owen	1948

References (Food)

1. Albert, J.O., Long, H.F., and Hammer, B.W. 1944 Classification of the organisms important in dairy products. IV. Bacterium linens. Agric. Exp. Sta., Iowa State College of Agriculture and Mechanic Arts. Research Bull., No. 328, 234-259.
2. Alessandrini, G., and Sampietro, G. The vitality of cholera vibriones in milk and on the fly. Ann. Igiene Sper., 22, 623-650.
3. Anderson, C.R. 1944 Survival of rickettsia in different diluents. J. Bact., 47, 519.
4. Anonymous 1921 Thirty-third Annual Rept. of the Louisian Agric. Exp. Sta.
5. Anonymous 1923 Under section on foreign letters from Paris, May 24, 1923, "Typhoid fever in Paris". J. Am. Med. Assoc., 80, 1628.
6. Anonymous 1927 2nd Prog. Rept. F.andM. Dis. Res. Com. Min. of Agric. and Fish.
7. Anonymous 1944 Cheese-carrying typhoid in Alberta. Canad. Dairy and Ice Cream J., 23, 40.
8. Arguelles, M.V. 1927 Viability of cholera vibrio in various menstrua. Rev. Filipina de Med. y Farm., 18, 137-140.
9. Ayres, J.C., and Slosberg, H.M. 1949 Destruction of Salmonella in egg albumen. Food Technol., 3, 180-183.
10. Babcock, C.J., Stabile, J.N., Randall, R., and Windham, E.S. 1947 Frozen homogenized milk. II. Effect of freezing and storage temperatures on the chemical and bacteriological properties of homogenized milk. J. Dairy Sci., 30, 49-54.
11. Babudieri, B., Moscovici, N.I. 1950 Richerche sul comportamento di Coxiella burneti di fronte ad alcuni agenti fisici e chimici. Rend. 1st Superiore Sanita, Rome, 13, 739-748.
12. Bachmann, W., and Lodenkämper, H. 1943 Versuche ueber die Lebensfähigkeit von Erregern der bakteriellen Ruhr bei Verwendung von Brot als Keimträger. Arch. Hyg. Bakt., 130, 77-84.
13. Barthel, C. 1924 Length of life of lactic acid bacteria in chalked milk and in soil cultures. Kgl. Landtbruks-Akad. Handl. Tid., 63, 642-650.
14. Bassenge, R. 1903 Ueber das Verhalten der Typhusbazillen in der milch unoderen Produkten. Deutsch. Med. Wochnschr., 29, 675-679.
15. Beard, P.J., and Cleary, P.J. 1932 The importance of temperature for the survival time of bacteria in acid foods. J. Prev. Med., 6, 141-144.
16. Beaudette, F., Hudson, C., Bivins, J., and Miller, B. 1948 The viability of dried viruses of avian origin. Am. J. Vet. Res., 9, 190-194.
17. Belin, M., Mutermilch, S., and Salamon, E. 1933 Effect of protective substances on heat resistance of certain bacteria. Compt. rend. soc. biol., 114, 1278-1281.
18. Beranek, J. 1948 Studie zivotnosti anthraxovych spor na rostlinstvu zamorene pudy. Casopis Ceskoslov. Vet., 3, 557-563.
19. Berry, A.E. 1927 Viability of pathogenic organisms in butter. J. Prevent. Med., 1, 429-442.

20. Berry, J.A. 1932 Bacteria question in cold packing. Western Canner and Packer, 23, 17-18.
21. Berry, J.A. 1933 Destruction and survival of microorganisms in frozen pack foods. J. Bact., 26, 459-470.
22. Berry, J.A. 1933 Lactobacilli in frozen pack peas. Science, 77, 350-351.
23. Berry, J.A., and Diehl, H.C. 1934 Freezing storage in relation to microbial destruction and retention of quality in sweet cider. Proc. Am. Soc. Hort. Sci., 32, 157-159.
24. Berry, J.A. 1936 Microbiological studies of frozen pack berries with special reference to effects of carbonation. Proc. Am. Soc. Hort. Sci., 33, 224-226.
25. Berry, J.A. 1937 Microbiology of frozen pack vegetables. Western Canner and Packer, 29, 14-16.
26. Berry, J.A. 1946 Bacteriology of frozen foods. J. Bact. 51, 639.
27. Bey, M.K. 1948 Effect of absolute humidity of atmosphere on first wave of cholera epidemic in Egypt in 1947. J. Roy. Egypt. Med. Assoc., 31, 39-72.
28. Bharucha, F.R., and Bharucha, K.H. 1938 The viability of certaine pathogenic microorganisms in various fresh fruits in India. A preliminary note on the viability of *Vibrio cholerae* in watermelon.. J. Univ. Bombay, 6, 35-40.
29. Bhat, J.V., and Rachunath, M. 1948 Watermelon and food-poisoning. Current Science, 17, 264-265.
30. Bhat, J.V., and Reporter, R.N. 1949 Fate of some intestinal pathogenic bacteria in Dahi. Indian J. Dairy Sci., 2, 99-107.
31. Blair, J., and Lang, O. 1934 Effect of low temperature freezing on the encysted larvae of *Trichinella spiralis*. Studies on muscle of rats, guinea pigs and hogs. J. Infectious Diseases, 55, 95-104.
32. Bolley, H.I., and Field, W. 1898 *Bacillus typhi abdominalis* in milk and butter. Centr. Bakt. Abt. II, 4, 881-887.
33. Bolten, J. 1918 Effect of freezing on organisms of typhoid and diphtheria. U.S. Pub. Health Rep., 33, 163.
34. Bowman, M. 1942 An epidemic of typhoid fever due to infected cheese. Manitoba, Dec. 1939-March 1940. Canad. Pub. Health J., 33, 541-547.
35. Breazeale, E.L., and Greene, R. 1951 Microbiological studies of popcorn. J. Am. Osteopath. Assoc., 50, 630-631.
36. Bruck, C. 1903 Experimentalle Beiträge zur Frage der Typhusverbreitung durch Butter. Deutsch. Med. Wochnschr., 29; 460-462.
37. Bryan, C., and Bryan, P.S. 1944 The viability of certain udder infection bacteria in butter made from raw cream. J. Milk Technol., 7, 65.
38. Buchanan, G.E. 1918 Study of an outbreak of bacillary dysentery. Lancet, 2, 166.
39. Buchbinder, L. Laughlin, V., Walter, M., and Dangler, G. 1949 A survey of frozen precooked foods with special reference to chicken a la king. J. Milk and Food Technol., 12, 209-213.
40. Burbury, Y.M. 1928 Survival of the foot-and-mouth disease virus outside the body. Ann. Appl. Biol., 15, 139-142.

41. Burton, M.O. 1949 Comparison of coliform and enterococcus organisms as indices of pollution in frozen foods. Food Res., 14, 434-438.

42. Burton, M.O. 1949 The types of coli-aerogenes organisms in frozen vegetables. Canad. J. Pub. Health, 40, 361-363.

43. Buttiaus, R., and Kesteloot, A. 1949 Etude bacteriologique des "petites Bieres" dans le nord de la France. Ann. Inst. Pasteur, Lille, 2, 12-20.

44. Campbell, H. 1932 The viability and growth of certain micrcorganisms common to frozen-pack fruits and vegetables at temperatures below 32 fahrenheit. Master's Thesis, Univ. of Washington Library, Seattle, Washington.

45. Campbell, A.G., and Gibbard, J. 1944 The survival of Eberthella typhosa in cheddar cheese manufactured from infected raw milk. Canad. J. Pub. Health, 35, 92, 158-164.

46. Carpenter, C.M., and Boak, R. 1928 Brucella abortus in milk and dairy products. Am. J. Pub. Health, 18, 743-751.

47. Cautley, E. 1896-1897 Report on the behaviour of the typhoid bacillus in milk. Rept. Med. Off. Local Govt. Bd., London.

48. Ceredi, A. 1929 Role of green vegetables in epidemiology of typhoid. Igiene. Mod., 22, 1-14.

49. Chambers, W.H. 1920 Germicidal action in milk. J. Bact., 5, 527.

50. Cherry, W.B., Scherago, M., and Weaver, R.H. 1942 The occurrence of Salmonella in retail market meats. J. Bact., 43, 49.

51. Colien, F.E. 1942 The microbiology of frozen eggs. I. Presence and significance of coliform organisms in frozen eggs. J. Bact., 43, 47.

52. Cookson, H.A. 1926 Persistence of tubercle bacilli in butter from tuberculous milk. Brit. Med. J., 2, 637.

53. Creel, R.H. 1912 Vegetables as a possible factor in the dissemination of typhoid fever. U.S. Pub. Health Repts., 27, 187-193.

54. Crossley, E.L. 1942 Coliform organisms in cheddar cheese. Proc. Soc. Agric. Bact., 16.

55. Dahlberg, A.C. 1946 Occurrence and survival of Brucella in cheese. New York State Assoc. of Milk Sanitarians, 20, 195-200.

56. Davis, D.J. 1914 The growth and viability of streptococci of bovine and human origin in milk and milk products. J. Infectious Diseases, 15, 378-388.

57. Demme, H. 1925 Uber den Nachweiss und die Haltbarkeit von Typhus-bakterien in sauer Milch, Kefir und Joghurt. Klin. Wochnschr., 4, 2351.

58. Dobrosklonsky, S. 1911 Uber die Lebensdauer der Choleravibrionen in Weintrauben. Centr. Bakt. Abt. 2, 48, 679.

59. Doyle, L.P. 1930 The length of survival of paratyphoid bacilli in foodstuffs. J. Infectious Diseases, 47, 92-94.

60. Dubovsky, B.J., and Meyer, K.F. 1922 The occurrence of B. tetani in soil and on vegetables. J. Infectious Diseases, 31, 614-616.

61. Duff, P.H., and Hardison, A.E. 1942 Meat-borne typhoid outbreak in Tennessee. Southern Med. J., 35, 139.

62. Editorial 1926 The frequency of botulism. J. Am. Med. Assoc., 86, 482-483.
63. Eriksson, J. 1941 En epidemi av paratyfus-Newport i Värmland 1940. Nordisk Hyg. Tidskr., 22, 163-174.
64. Eyre, J.W., Et Al The presence of M. melitensis in milk and milk products. Gr. Brit. Com. for the Invest. of Med. Fever Report, 1905-1907.
65. Fabian, F.W. 1947 Cheese and its relation to disease. Am. J. Pub. Health, 37, 987-996.
66. Fabian, F.W., and Trout, G.M. 1943 Influence of various treatments on the bacterial content of frozen cream. J. Dairy Sci., 26, 959-965.
67. Falk, L.L. 1949 Bacterial contamination of tomatoes grown in polluted soil. Am. J. Pub. Health, 39, 1338-1342.
68. Fellers, C.R. 1919 Longevity of Bacillus radicicolaon legume seeds. Soil Sci., 7, 217-232.
69. Felsenfeld, O., and Young, V.M. 1945 The viability of Salmonella on artificially contaminated vegetables. Poultry Sci., 24, 353-355.
70. Felsenfeld, O., Young, V.M., and Yoshimura, T. 1950 A survey of Salmonella organisms in market meat, eggs, and milk. J. Am. Vet. Med. Assoc., 116, 17-21.
71. Fitch, C.P., and Bishop, L.M. 1933 Presence of Brucella abortus bang in raw milk, butter, and ice cream. Proc. Soc. Exp. Biol. and Med., 30, 1205-1207.
72. Foley, A.E., and Poisson, E. 1945 A cheese-borne outbreak of typhoid fever, 1944. Canad. J. Pub. Health, 36, 116-118.
73. Foltz, V., and Lord, T. 1951 Bacteriologic studies on margarine. Food Research, 16, 216-221.
74. Fraenkel, E., and Kister, J. 1898 Ueber Typhusbacillen in Buttermilch. Munchen. Med. Wochnschr., 45, 197-198.
75. Frank, M., and Hess, E. 1941 Studies on salt fish. IV. Survival of Eberthella typhosa and Escherichia coli on salt fish. J. Fish Res. Bd., Canada, 5, 249-252.
76. Frost, W.D., and Whitman, R. 1905 The viability of B. dysenteriae Shiga. Science, 21, 483.
77. Galippe, V. 1887 Note sur la presence de micro-organismes dans les tissues vegetaux. Compt. rend. soc. biol., 4, 410-416.
78. Gebhart, L.P., and McKay, W.M. 1946 Epidemic poliomyelitis. J. Pediat., 28, 1-13.
79. Geer, L.P., Murray, W.T., and Smith, E.T. 1933 Bacterial content of frosted hamburg steak. Am. J. Pub. Health, 23, 673-676.
80. Genevray, J., and Bruneau, J. 1938 Survival period of the cholera vibrion in some food products used in Annam. Compt. rend. soc. biol., 128, 148-150.
81. Gibbons, N.E., and Fulton, C.O. 1943 Dried whole egg powder. VII. Effect of temperature and moisture on the bacterial content of liquid and dried egg. Canad. J. Res., 21, 332.
82. Gilman, H.L., Dahlberg, A.C., and Marquardt, J.C. 1946 The occurrence and survival of Brucella abortus in cheddar and limburger cheese. J. Dairy Sci., 29, 71-85.
83. Glass, V., Goodhart, G.W., and Straker, E.A. 1946 An outbreak of food poisoning caused by Salmonella typhimurium conveyed by infected gelatin. Month. Bull. Med. Res. Counc., 5, 90-94.

84. Gould, S., Kaasa, L. 1949 Low temperature treatment of pork. Effect of certain low temperatures on viability of trichina larvae. Am. J. Hyg., 49, 17-24.
85. Grattan, H.W. 1939 An outbreak of twenty-eight cases of cholera among British troops in Benares Sept., 1912. J. Roy. Army Med. Corps, 72, 21-25.
86. Gregory, D. 1948 Salmonella infections of turkey eggs. Poultry Sci., 27, 359-366.
87. Gunderson, M.F., and Rose, K.D. 1948 Survival of bacteria in precooked, fresh frozen food. Food Research, 13, 254-263.
88. Haines, R.B. 1933 Ann. Rept. Food Invest. Bd. for 1932.
89. Haines, R.B., and Elliot, E.M.L. 1944 Some bacteriologic aspects of dehydrated foods. J. Hyg., 43, 370-381.
90. Hampil, B. 1932 The influence of temperature on the life processes and death of bacteria. Quart. Rev. Biol., 7, 172-196.
91. Hartsell, S.E. 1950 Growth characteristics of Salmonella in defrosted whole eggs. Bact. Proc., 1950, 14.
92. Hartsell, S.E. 1951 The growth initiation of bacteria in defrosted eggs. Food Research, 16, 97-106.
93. Hartsell, S.E. 1951 The longevity and behaviour of pathogenic bacteria in frozen foods: the influence of plating media. Am. J. Pub. Health, 41, 1072-1077.
94. Heim, L. 1889 Uber das Verhalten der Krankheitserreger der Cholera des Typhus, und der Tuberkulose in Milch, Butter, Molken und Käse. Arb. kaiserl. Gesundh., 5, 294-311.
95. Henderson, W.M., and Brooksby, J.B. 1948 Survival of foot and mouth disease virus in meat and offal. J. Hyg., 46, 394-402.
96. Herdman, B. 1899 Thompson-Yates Lab. Rept. No. 2.
97. Hesse, W. 1889 Unsere Nahrungsmittel als Nährböden für Typhus und Cholera. Z. Hyg., 5, 527-546.
98. Higginbottom, C. 1948 The survival of the microflora of milk powders during storage at different relative humidities. Proc. Soc. Appl. Bact., 1948, 18-19.
99. Hill, H.W. 1909 The survival of B. typhosus in milk when used in ordinary breakfast-table coffee and tea. Am. Pub. Health Assoc. Rep. 1908, 34, 129-145.
100. Hilliard, C.M., and Davis, M.A. 1918 The germicidal action of freezing temperatures by bacteria. J. Bact., 3, 423-431.
101. Hilliard, C.M., Torission, C., and Stone, R.P. 1915 Notes on the factors involved in the germicidal effect of freezing and low temperatures. Science, 42, 770-771.
102. Hoder, F. 1928 Bacteria on raw fruit. Deutsche Med. Wochnschr., 54, 1806-1808.
103. Honda, Y. 1938 Die Bakteriold eischen Beobachtungen ueber die sauer Milch in der inneren Mongolei Mitteilung V. Ueber den Verlauf von B. abortus Bang und Tuberkelbazillen, die mit sauer Milch Vermengt wurden. J. Orient. Med., 28, 74.
104. Hucker, G.J., and Robinson, W.B. 1951 Bacteria in frozen vegetables. Food in Canada, 11, 14-15.
105. Huddleson, I.F., Baltzer, B., and Trout, G.M. 1949 The viability of Brucella abortus in milk and in cream during heat treatment in electrically operated home pasteurizers. J. Dairy Sci., 32, 29-32.

106. Huebner, R.J., Jellison, W., Beck, M., Parker, R., and Shepard, C. 1948 Recovery of Rickettsia burneti from raw milk. U.S. Pub. Health Rep., 63, 214-222.
107. Humpesch, H. 1949 Uber die Lebensfähigkeit von Typhus- und Paratyphus-bakterien in Bier and Bierersatz-getränken. Brauwissenschaft, 1949, 17-19.
108. Hutchings, L.M., McCullough, N.B., Donham, C.R., Eisele, C.W., and Bunnell, D.E. 1951 The viability of Brucella melitensis in naturally infected cured hams. U.S. Pub. Health Rep., 66, 1402-1408.
109. Ignatovich, Z.A., and Lebedeva, M.A. 1935 Retention of viability of Escherichia coli and Proteus vulgaris in modern culinary practice of meat and fish handling. Voprosui Pitaniya, 4, 1-15.
110. James, L.H. 1932 The microbiology of frozen foods. Fruit Products J. Am. Vinegar Industry, 12, 110.
111. James, L.H. 1933 The microbiology of frozen foods. Ice and Cold Storage, 36, 150-151, 173-174.
112. Jansen, J. 1942 Mensch als overdrager van het mond en Klauwzeer virus. Tijdschr. Diergeneesk, 69, 612.
113. Jellison, W. 1948 Q fever studies in Southern California. VIII. Recovery of Coxiella burneti from butter made from naturally infected and unpasteurized milk. U.S. Pub. Health Repts., 63, 1712-1713.
114. Jensen, L.B. 1945 Microbiology of meats. Garrard Press, Champaign, Ill., 2nd Ed.
115. Johns, C.K., and Berard, H.L. 1946 The effect of freezing and cold storage upon the bacterial content of egg melange. Scientific Ag., Ottawa, Canada, 26, 34-43.
116. Johnston, M.M., and Kaake, M.J. 1935 Bacteria on fresh fruit. Am. J. Pub. Health, 25, 945-947.
117. Jones, E.R. 1943 Seasonal variation in incidence of Brucella abortus in raw milks. J. Path. Bact., 55, 357-362.
118. Jordan, E.O. 1925 Viability of typhoid bacilli in shell oysters. J. Am. Med. Assoc., 84, 1402-1403.
119. Kaiser, K. 1921 Ueber die Wachstums fähigkeit von Paratyphuserregern in Yoghurt. Centr. Bakt. Abt. I Orig., 86, 554-564.
120. Kankaapää, N.I. 1913 Inaug. Diss., Dresden, 1911 (Ref. Zentr. Bakt., 56, 202.
121. Kastli, P. 1948 Die Lebensfahigkiet von Mycobacterium tuberculosis in Schweizerischen Kasesorten. Schweiz. Z. Path. Bact., 11, 408-413.
122. Kastli, P., and Binz, M. 1949 Die Lebenfahigkeit von Mycobacterium tuberculosis in verschiedenen Kasesorten. Milchwissenschaft, 4, 391-394.
123. Katrandjieff, K. 1929 Resistance of tubercle bacilli to heat; experiments. Compt. rend. soc. biol., 100, 26-28.
124. Keith, S.C. 1913 Factors influencing the survival of bacteria at temperatures in the vicinity of the freezing point of water. Science, 37, 877.
125. Kinyoun, C. 1925 Viability of B. typhosus in stored shell oysters. U.S. Pub. Health Rep., 40, 819-823.
126. Klein, E. 1905 Experiments and observations on the vitality of the bacillus of typhoid fever and of sewage microbes in oysters and other shellfish. Investigations on behalf of the Worshipful Company of Fish Mongers, London.

127. Klein, E. 1905 The vitality of the typhoid bacillus in shell-fish. Tr. Path. Soc., London, 56, 230-238.
128. Kliewe, H., and Eldracher, E. 1935 Ueber die Lebensdauer der Typhus und Paratyphusbazillen in sterilisierter and roher Milch. Centr. Bakt. Parasitenk. Abt. 1, Orig., 135, 269-275.
129. Kliewe, H., and Hsü, M. 1935 Ueber die Ursache des Absterbens von Typhusbazillen in sauerer Milch. Deutsche Me. Wochnschr., 61, 1154-1155.
130. Kliewe, H., and Schuppener, A. 1937 Ueber die Lebensdauer der Tuberkelbazillen in sauerer Milch. Zentr. Bakt., 139, 180-183.
131. Kling. D., Levaditi, C., and Lepine, N.I. 1931 Conservation de l'activite pathogène du virus poliomyelitique incorpore au beurre. Bull. Acad. Med., Paris, 106, 245-248.
132. Koser, S.A., Edmondson, R.B., and Giltner, L.T. 1921 Observations on Bacillus botulinus infection of canned spinach. J. Am. Med. Assoc., 77, 1250-1253.
133. Koser, S.A. 1922 Development of paratyphoid-enteritidis group in various foodstuffs. J. Infectious Diseases, 31, 79.
134. Koser, S.A., and Skinner, W.W. 1922 Viability of the colon-typhoid group in carbonated water and carbonated beverages. J. Bact., 7, 111-121.
135. Kosikowsky, F.V., and Dahlberg, A.C. 1948 The growth and survival of Streptococcus fecalis in pasteurized milk American Cheddar cheese. J. Dairy Sci., 31, 285-292.
136. Kredba, M. 1935 Microbes du groups typhus-coli dans le lait et dans ses produits. Prakt. lek., 136.
137. Krueger, A.P., Hope, J.W., Rosenberg, L.R., and West, N.S. 1942 Inactivation of influenza virus by human skin. U.S. Nav. Med. Bull., 40, 839-846.
138. Krumwiede, C., Jr., and Noble, W.C. 1914 The viability of typhoid bacillus in sour cream. Am. J. Pub. Health, 4, 1006.
139. Lafar, N.I. Gov't. Exp. Sta. Record, 3, 223.
140. Landsteiner, K., Levaditi, C., and Pastia, M. 1911 Experimental studies of acute poliomyelitis. Ann. Inst. Pasteur, 25, 805.
141. Laser, H. 1891 Uber das Verhalten von Typhusbacillen, Cholerabacterien und Tuberkelbacillen in der Butter. Z. Hyg., 10, 513-520.
142. Lawson, R.B., and Melnick, J.L. 1947 Heat inactivation of murine poliomyelitis viruses. J. Infectious Diseases, 80, 201-208.
143. Lazarus, A. 1890 Die Wirkungweise der gebräuchlicheren Mittel zur Conservirung der Milch. Zentr. Hyg., 8, 207-239.
144. Lerche, N.I. 1931 Abortus-Bang-Bakterien in Milch und Milchprodukten vom Rind. Z. Infektionskrankh., 38, 253-328.
145. Lin, C. 1945 Preliminary survey for detection of intestinal pathogens among pickled vegetables in Chengtu. Chinese Med. J., 63A, 159-161.
146. Link, H.L., and Pancoast, H.M. 1949 Antiseptic cooling retains top quality in perishables. Food Industries, 21, 737-741.

147. Lockhead, A.G., and Jones, A.H. 1936 Studies of numbers and types of microorganisms in frozen vegetables and fruits. Food Research, 1, 29-39.
148. Lockhead, A.G., and Jones, A.H. 1938 Types of bacteria surviving in frozen-pack vegetables. Food Research, 3, 299-306.
149. Loncin, N.I., and Geairain, J. 1950 La virulence du mycobacterium tuberculosis dans le fromage blanc. Rev. Fermentations et Indust. Aliment, 5, 481-484.
150. Lund, A.J., and Halvorson, H.O. The effects of low temperatures on enzymes and microorganisms. Hormel Institute publication No. 62.
151. McCallum, G.B., and Kirkpatrick, J. 1934 Vitality of tubercle bacilli preserved in frozen milk. J. Hyg., 34, 141-143.
152. McCleskey, C.S., and Christopher, W.M. 1941 The longevity of certain pathogenic bacteria in strawberries. J. Bact., 41, 98-99.
153. McFadyean, J. 1895 J. Comp. Path. Therap., 8, 326.
154. MacFarlane, V.H. 1940 Behaviour of microorganisms at subfreezing temperature. Distribution and survival of microorganisms in frozen cider, frozen syrup-packed raspberries, and frozen brine packed peas. Food Research, 5, 43-57, 59-68.
155. Magoon, C.A. 1932 Microorganisms as affecting frozen foods. Ind. Eng. Chem., 24, 669-671.
156. Mallam, P.C., and Alhadeff, R. 1946 Salmonella infection in man conveyed by ducks' eggs. Lancet, 14, 887-888.
157. Marsh, P. 1918 Survival of typhoid bacillus in sour milk. Am. J. Pub. Health, 8, 590.
158. Mattick, A.T.R., and Hirsch, A. 1946 Sour milk and the tubercle bacillus. Lancet, 250, 417-418.
159. Maurel, E. 1910 Survivance du colibacille et du bacille d'Eberth sur les charcuteries. Compt. rend. soc. biol., 69, 574-577.
160. Medical Research Council 1947 The bacteriology of spray-dried egg with particular reference to food poisoning. Med. Res. Counc. Spec. Rept. Serv., 260, 6-66.
161. Melick, C.O. 1917 The possibility of typhoid infection through vegetables. J. Infectious Diseases, 21, 28-38.
162. Melsens, M. 1870 Note on the vitality of yeast in beer. Compt. rend. acad. sci., 70, 629-634.
163. Meyer, K.F. 1944 Cheese-borne epidemics of typhoid fever. California and West. Med., 61, 137-139.
164. Mills, R.G., Bartlett, C.L., and Kessel, J.F. 1925 The penetration of fruits and vegetables by bacteria and other particulate matter. Am. J. Hyg., 5, 559-579.
165. Minnesota State Board of Health, 1911 3rd Biennial Rept.
166. Mitchell, O.W.H. 1915 Viability of Bacillus typhosus in ice cream. J. Am. Med. Assoc., 65, 1795-1797.
167. Mitchell, R.B., Garlock, F.C., and Broh-Kahn, R.H. 1946 An outbreak of gastroenteritis presumably caused by Salmonella pullorum. J. Infectious Diseases, 79, 57-62.
168. Mohler, J.R., Washburn, H.J., and Rogers, L.A. 1911 The viability of tubercle bacilli in butter and cheese. U.S. Dept. Agr., Bur. of Animal Ind., Ann. Rept., 26, 179-191.

169. Morgan, H.R., Early, R.L., and McClain, M.E. 1946 Studies on the cultivation of Japanese B encephalitis virus in eggs. J. Infectious Diseases, 79, 278-281.
170. Morris, N.I. 1921 33rd Annual Report of the Louisiana Agric. Exper. Sta.
171. Morrison, E.W., and Rettger, L.F. 1930 Bacterial spores. I. A study in heat resistance and dormancy. J. Bact., 20, 299-312.
172. Müller-Claus, G. 1938 Der Wärmegang in Wurstwaren beim Räuchern und Brühen und deren Einfluss auf die Bakterienflora im allgemeinen und einige pathogene Keime insbesondere. Arch. Hyg. Bakt., 120, 1-22.
173. Murgia, A. Colimetria nella acque e colimetria negli alimenti. Ann. Igiene, 1939, 734-738.
174. Murray, C., McNutt, S.H., and Purwin, P. 1932 The effect of pasteurization upon Brucella melitensis variant suis. J. Am. Vet. Med. Assoc., 80, 336-342.
175. Olesiuk, O.M. 1951 Influence of environmental factors on viability of Newcastle disease virus. Am. J. Vet. Res., 12, 152-155.
176. Ommyoji, M. 1931 Disinfection of vegetables and fruits by hot water. J. Orient. Med., 14, 30.
177. Orakov, S.L. 1925 Versuche über Thermoresistenz, Thermoresistenz in verschiedenen Nährböden, Thermoresistenz von Culturen verschiedenen Alters. Z. Hyg. Infektionskrankh., 105, 317-341.
178. Osler, W. 1901 Practice of Medicine, 4th Ed.
179. Owen, W.L., and Mobley, R.L. 1948 A new species of Torulae occurring in and transmitted by the American cockroach Periplaneta americana (Linn). Food Research, 13, 281-290.
180. Palladina, O.K., and Krotova, T.A. 1935 Significance and control of intestinal bacteria in milk products. Milchwirtschaft. Forsch., 17, 212-221.
181. Panja, G., and Ghosh, S.K. 1945 Viability of cholera organisms in milk curd. Indian Med. Gaz., 80, 390-392.
182. Parry, E.W. 1946 Prevalence of Clostridium botulinus in soils of central New York State. Food Research, 11, 203-209.
183. Pennington, M.E., and Walter, G. 1907 A bacteriological study of commercial ice cream. New York, Med. J., 86, 1013-1018.
184. Peres, G., and Granon-Fabre, P. 1936 Recherches relatives a la presence de Brucella melitensis dans le lait et les fromages de Cherres. Bull. Soc. Sci. Vet., Lyon, 39, 110-113.
185. Pettigrew, W.W. 1928 The influence of air pollution on vegetables. Gardener's Chron., London, 84, 292.
186. Pfuhl, E. 1902 Vergleichende Untersuchungen über die Haltbarkeit der Ruhr bacillen und der Typhus bacillen auberhalt des menschlichen Körpers. Z. Hyg. Infektionskrankh., 40, 555-566.
187. Prescott, S.C., Bates, P.K., and Highlands, M.E. 1932 Numbers of bacteria in frozen food stored at several temperatures. Am. J. Pub. Health, 22, 257-262.
188. Prucha, M.J., and Brannon, J.M. 1926 Viability of Bacterium typhosum in ice cream. J. Bact., 11, 27-29.

189. Pullinger, E. J. 1935 Examination of milk products for tubercle bacilli and Brucella abortus. Lancet, 1, 1342.
190. Pullinger, E. J., and Kemp, A. E. 1938 Growth of Salmonella typhi and certain other members of the Salmonella group in milk and butter stored at atmospheric temperatures. J. Hyg., 38, 587-595.
191. Ranta, L. E., and Dolman, C. E. 1941 Preliminary observations on the survival of S. typhi in Canadian Cheddar type cheese. Canad. J. Pub. Health, 32, 73-74.
192. Remlinger, P., and Nouri, O. 1909 Les microbes pathogenes du sol peuvent-ils penetrer a l'interieur des vegetaux. Compt. rend soc. biol., 67, 646-647.
193. Rice, E. B. 1938 Studies on coliform bacteria found in butter. Queensland Agric. J., 50, 708-715.
194. Robinton, E. D., and Geming, E. F. 1945 The effect of temperature on coliform organisms in milk and cream. J. Milk Tech., 8, 97.
195. Rubenstein, N. I. 1902 Ueber das Verhalten einiger pathogener Bakterien in der Buttermilch. Arch. Kinderheilk, 35, 3-6.
196. Rudolfs, W., Galk, L., and Ragotzkie, R. 1050 Literature review on the occurrence and survival of enteric, pathogenic, and related organisms in soil, water, sewage and sludges and on vegetation. I. Bacterial and virus diseases. Sewage and Indust. Wastes, 22, 1261-1281.
197. Rudolfs, W. L., Falk, L., and Ragotzkie, R. A. 1950 Literature review on the occurrence and survival of enteric, pathogenic, and related organisms in soil, water, sewage, and sludges and on vegetation. 11. Animal parasites. Sewage and Indust. Wastes, 22, 1417-1427.
198. Rudolfs, W., Falk, L. L., and Ragotzkie, R. A. 19 51 Contamination of vegetables grown in polluted soil. Sewage and Indust. Wastes, 23, 253-268.
199. Rudolfs, W., Falk, L., and Ragotzkie, R. 1951 Contamination of vegetables grown in polluted soil. IV. Bacterial decontamination. Sewage and Indust. Wastes, 23, 739-751.
200. Sabrazes, J., and Marcandier, A. 1907 Action du vin sur le bacille d'Eberth. Ann. de l'Inst. Pasteur, 21, 312-320.
201. Scamman, C. L., Leonard, H. L. 1927 Scarlet fever outbreak due to infected food. Am. J. Pub. Health, 17, 311-316.
202. Schneiter, R., Bartram, M., and Lepper, H. 1943 Bacteriological and physical changes occurring in frozen eggs. Influence of defrosting and prolonged storage on bacterial count and odor. J. Assoc. Official Agr. Chem., 26, 172-173.
203. Schoenholz, J. R., Esty, N.I., and Meyer, K.F. 1923 Toxin production and signs of spoilage in commercially canned vegetables and fruits inoculated with detoxified spores of B. botulinus. J. Infectious Diseases, 33, 289-327.
204. Schäfer, A., and Erdmann, B. 1943 Beobachtugen bei einer Tularemie-Epidemie. Z. Hyg., Infektionskrankh., 124, 624-635.
205. Seelemann, M., and Sieg, G. 1938 Zur Frage der Hitzewiderstandsfahigkeit der Brucella abortus und ihre Bedeuting für die Pasteurizierung der Milch. Molkereizta Hildesh., 52, 3047-3050.

206. Seitz, C. 1886 Bakteriol. Studien zur Typhusätiologie. München 1886.
207. Serpa Santos, M., and Jesuina da Conceicao Fernandes 1939 Alguns ensaios sobre a vitalidade das bacterias nas bebidas alcoolicas. Noticias Farmaceut., 5, 424-437.
208. Shengelidze, V. 1897 Bacteriological examination of beer must and the continuous vitality in it of cholera. Voyenno-Med. J., 188, 548-553.
209. Sirena, S., and Scagliosi, G. 1895 Durata in vita del bacillo del carboncaio nel terreno nell acquapotabile, inquella di mare e nel materiale di fogna. Centr. Bakt. Abt. 1, 17, 318-319.
210. Smart, H.F. 1934 Microorganisms surviving the storage period of frozen pack fruits and vegetables. Phytopathology, 24, 1319-1331.
211. Smart, H.F. 1935 Growth and survival of microorganisms at sub-freezing temperatures. Science, 82, 525.
212. Smart, H.F. 1937 Microbiological studies on cultivated blueberries in frozen pack. Food Research, 2, 429-434.
213. Smart, H.F. 1939 Further studies on behaviour of microorganisms in frozen cultivated bluberries. Food Research, 4, 287-292.
214. Smeall, J.T. 1932 Bacteria on fruit. Brit. Med. J., 2, 917-919.
215. Smith, J. 1932 Brucella abortus in milk. J. Hyg., 32, 354-366.
216. Stanley, L.L., Garfinkle, F.E., and Goddard, W.P. 1930 Prison epidemic of Flexner's dysentery. J. Am. Med. Assoc., 94, 857-860.
217. Starin, W.A. 1926 Relationship of incubation temperature to viability rate of growth and toxin production of Clostridium botulinum in different vegetables. J. Infectious Diseases, 38, 106-114.
218. Stark, C.N., and Stark, P. 1929 Relative thermal death rates of young and mature bacterial cells. J. Bact., 18, 333-337.
219. Stever, W. 1941 Ueber die Lebensdauer von Ruchrkeimer in Vollmilk und Buttermilch. Arch. Hyg. Bakt., 126, 233-238.
220. Stiles, G.W. 1945 Brucellosis in goats. Recovery of Brucella melitensis from cheese manufactured from unpasteurized goats milk. Rocky Mt. Med. J., 42, 18-25.
221. Stockmayer, W. 1935 Vergleichende Untersuchungen über den Bangbakteriengehalt von Rahm, Butter, Mager- und Buttermilch, Sowie Versuche über die Konservierung von Milchproben. Zentr. Bakt. Abt. 1, Orig., 133, 425-435.
222. Stockton, J.J., and Newman, J.P. 1950 The preservation of vibrio fetus by lyophilization. Cornell Vet., 40, 377-379.
223. Straka, R.P., and James, L.H. 1932 A health aspect of frozen vegetables. Am. J. Pub. Health, 22, 473.
224. Straka, R.P., and James, L.H. 1935 Clostridium botulinum, frozen vegetables. Further studies. J. Bact., 29, 313-322.
225. Surgella, M., and Dack, G.M. 1945 Growth of Staphylococcus aureus, Salmonella enteritidis and alpha type streptococcus experimentally inoculated in canned meat products. Food Research, 10, 108-113.

226. Tanner, F.W. 1934 Microbiological examination of fresh and frozen fruits and vegetables. Am. J. Pub. Health, 24, 485-492.
227. Tanner, F.W. 1944 The microbiology of foods. Garrard Press, Champaign, Illinois, 2nd Ed.
228. Tanner, F.W., Beamer, P.R., and Rickher, C.J. 1940 Further studies on development of Clostridium botulinum in refrigerated foods. Food Research, 5, 323-333.
229. Tanner, F.W., and Wallace, G.I. 1931 Effect of freezing on microorganisms in various menstra. Proc. Soc. Exp. Biol. Med., 29, 32-34.
230. Tanner, F.W., and Williamson, B.W. 1928 Effect of freezing on yeasts. Proc. Exp. Biol. Med., 25, 377-381.
231. Tetsumoto, S. 1930 Numerical variation and surviving period of Vibrio cholerae placed on aquatic food preparations. Jap. J. Exp. Med., 8, 353-363.
232. Tetsumoto, S. 1930 Numerical variation and surviving period of Bacillus typhosa placed on fresh aquatic products. Jap. J. Exp. Med., 8, 627-631.
233. Thomasson, H.L. 1944 A typhoid epidemic from cheese as experienced by a milk sanitarian. Monthly Bull. Indiana State Board of Health, 47, 283.
234. Thompson, R. 1933 Canadian Med. Assoc. J., 29, 9.
235. Tohyama, Y. 1930 Investigations concerning prevention of epidemic diseases due to aquatic products; resisting power of Vibrio cholerae against low temperatures. Jap. J. Exp. Med., 8, 327-352.
236. Tonney, F.O., and White, J.L. 1925 Viability of B. typhosus in oysters during storage. J. Am. Med. Assoc., 84, 1403-1406.
237. Toomey, J.A., Takacs, W.S., and Tischer, L.A. 1943 Attempts to recover poliomyelitis virus from fruit. J. Pediat., 23, 168-171.
238. Trevelyan, E.F. 1898 The behaviour of the diphtheria bacillus outside the human body. J. San. Inst. 1897, London, 18, 430-434.
239. Tucker, C.B., Cameron, G.M., Henderson, M.P., and Beyer, M. R. 1946 Salmonella typhimurium food infection from Colby cheese. J. Am. Med. Assoc., 131, 1119-1120.
240. Van Bever, A.K. 1943 Influence of temperature and pasteurization time on the enzymes and bacteria in milk. Enzymologia, 11, 7-18.
241. Van Drimmelen, G.C. 1948 The viability of Brucella abortus bovis in milk samples from infected cows. J. S. African Vet. Med. Assoc., 19, 58-60.
242. Van Eseltine, W.P., Nellis, L.F., Lee, F.A., Hucker, G.J. 1948 Effect of rate of freezing on bacterial content of frozen vegetables. Food Research, 13, 271-280.
243. Vasquez-Colet, A. 1924 Viability of intestinal pathogenic bacteria in fruits and Philippine foods eaten raw. Philippine J. Sci., 24, 35-39.
244. Versilova, P. 1937 Konservacija Br. melitensis v Ovecsen Molike i v Ovecji. Veterinary Bulletin, Weybridge (Abstract), 7, 414.

245. Virtanen, A.I. 1943 The hydrogen-ion concentration as a basis for the conservation of feeds and foods. Sudmen Kemistilehti, 16, 96-108.
246. Voille, N.I. 1931 La fievre ondulant. Maison and Cie, Paris.
247. Wade, E.M., Fellow, A.P.H., and Shere, L. 1928 Longevity of typhoid fever traced to cheese. Am. J. Pub. Health, 18, 1480-1488.
248. Wade, E.M., and Shere, L. 1929 Longevity of typhoid bacilli in Cheddar cheese; study following outbreak of typhoid fever traced to cheese. U.S. Nav. Med. Bull., 27, 518-527.
249. Wallace, G.I. 1938 The survival of pathogenic microorganisms in ice cream. J. Dairy Sci., 21, 35-36.
250. Wallace, G.I., Crouch, R. 1933 Microbiology of frozen foods. VI. The survival of pathogenic microorganisms in ice cream. J. Dairy Sci., 16, 315-316.
251. Wallace, G.I., and Park, S.E. 1933 Microbiology of frozen foods. IV. Longevity of certain pathogenic bacteria in frozen cherries and in frozen cherry juice. J. Infectious Diseases, 52, 146-149.
252. Wang, C.I. 1945 Chinese soybean sauce as transmitting agent of bacterial gastrointestinal infections. Am. J. Trop. Med., 25, 47-50.
253. Washburn, N.I. 1908 U.S. Dept. Agr. Bur. Animal Indust.
254. Watts, P.S. 1945 Effect on survival of dried cultures of Streptococcus agalactiae. J. Path. Bact., 57, 191-197.
255. Weiser, H.H. 1951 Survival of certain microorganisms in selected frozen foods. Quick Frozen Foods, 13, 50-51.
256. Weiss, H. 1921 Thermal death point of spores of B. botulinus in canned foods. J. Infectious Diseases, 29, 362.
257. Wethington, M.C., and Fabian, F.W. 1950 Viability of food-poisoning staphylococci and salmonellae in salad dressing and mayonnaise. Food Research, 15, 125-134.
258. Wilson, F.L., and Tanner, F.W. 1945 Behaviour of pathogenic bacteria in fermented milks. Food Research, 10, 122-131.
259. Wilson, G.S., and Shipp, H.L. 1938 The examination of some tinned foods of historical interest- four bacteriological investigations. Chem. Indust., London, 57, 834-836.
260. Wilson, M.E. 1948 Survival of Salmonella organisms in stored egg powder. Food Indust., 20, 873-874, 971-972.
261. Winfield, G.F., and Chin, T. 1938 Studies on the control of fecal-borne diseases in North China. VI. The epidemiology of Ascaris lumbricoides in an urban population. Chinese Med. J., 54, 233.
262. Winter, A.R., and Wilkin, M. 1947 Holding and storage of egg products to control bacteria. Am. Egg and Poultry Rev., 8, 74.
263. Wolford, E.R., and Berry, J.A. 1948 Condition of oranges as affecting bacterial content of frozen juice with emphasis on coliform organisms. Food Research, 13, 172-178.
264. Yale, M.W., and Marquarot, J.C. 1940 Factors affecting the survival of Streptococcus pyogenes in cheese. J. Milk Tech., 3, 326-333.

265. Zeiss, H. 1926-1942 Tularemia epidemic in Southeastern Russia. Seuchen-Atlas.

References (Food) Addendum

1a. Alleev, B.S. 1936 Rate of death of bacteria during the thermal culinary treatment of food products. Voprosy Pitaniy, 5, 155-158.

2a. Alves, William 1935 Unwrapped bread with intestinal bacteria. S. African Med. J. 9, 91-192.

3a. Ayres, J.C. 1948 Epidemiology of Tularemia in Massachusetts with a review of the literature. New Eng. J. Med. 238, 187-194.

4a. Grubb, I;, Laurell, G., Lindquist, K.H. 1947 Spread of Typhoid-Paratyphoid infections by means of contaminated vegetables, Nord. Hyg. Tid., 28, 243-257.

5a. Holmes, Doris, and McCleskey, C.S. 1949 Bacteriology of shrimp. V. Effect of peel ng, glazing, and storage temperature on bacteria in frozen shrimp. Food Res., 14, 401-404.

6a. Lal, R.B. and Yacob, M. 1926 Relative suitability of certain foodstuffs as media for cultivation of V. cholerae with special reference to their relative role in dissemination of cholera. Ind. J. Med. Res., 14, 245-255

7a. Laurens, H. 1938 The physiologic effects of ultra-violet radiation. J. Amer. Med. Assoc. 111, 2385-2392.

8a. Lominsky, O. 1890 On the parasitism of a few pathogenic organisms on living plants. Cent. f. Bakt. Ref., 8, 325-329.

9a. Palayan, H. 1946 Septic Angina due to ingestion of grain which remained under snow all winter. Turk tip. Cem. Med., 12, 68-73.

10a. Russell, H.L. 1893 Bacteria in their relation to vegetable tissue. Johns Hopkins Hosp. Repts. 3, 223-263.

11a. Spaini, L.S. 1944 Efficacy of washing small fruit in boiling water to eliminate certain bacteria (Salmonella etc.) Rev. Assoc. Argent. Jietol. 2, 140-144.

12a. Tang, P.S., and Gaw, H.Z. 1937 Mechanism of death in unicellular organisms. 1. Delayed death and change in resistance to ultra-violet radiation in Paramecium Bursaria with age of culture. Chin. J. Phys. 11, 305-314.

13a. Topley and Wilson 1946 Principles of bacteriology and immunity.

14a. Vaindrakh, G.M. 1929 The influence of ultra short waves on microorganisms and the mechanism of their action. J. microbiol. Epidemiol. Immunobiol. 7, 156-157.

15a. Verge, J. and Grasset, E. 1928 Growth of bacteria in eggs at laboratory temperature and in frozen state. Compt. Rend. Acad. D. Sc., 186, 718-719.

16a. Whitney, R., Russel, L. 1951 An experimental approach to problems of control in quantitative studies of ultrasonic bactericidal effects. Food Res., 16, 205-215.

17a. Wolman, A. 1924 Hygienic aspects of sewage sludge as fertilizer. Eng. News-Record, 92, 198.

18a. Wright, C.T. 1950 Pollution of irrigation waters. Sewage and Indust. Wastes., 22, 1403, 1412.

FOOD

The following authors appear in the references but specific information pertaining to their work does not appear in the tables:

26.	Berry, J.A.	1946
27.	Bey, M.K	1948
31.	Blair, J.	1934
67.	Falk, L.L.	1949
90.	Hempil, B.	1932
110.	Landsteiner, K.	1911
140.	Pettigrew, W.W.	1928
197.	Rudolfs, W.L.	1950
198.	Rudolfs, W.	1951
208.	Shengelidze, V.	1897
209.	Sirena, S.	1895
237.	Toomey, J.A.	1943
240.	Van Bever, A.K.	1943
261.	Winfield, G.F.	1938
1a.	Alleev, B.S.	1936
4a.	Grubb, I.	1947
6a.	Laurens, H.	1938
8a.	Palayan, H.	1946
11a.	Tang, P.S.	1937
12a.	Vaindrakh, G.M.	1929
13a.	Whitney, R.	1951

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN INSECTS

TABLE 1 THE SURVIVAL OF BACILLUS SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
B. anthracis			
Stomach			
13-17C	exptl; 48-96 hr.		
37C	" 24-48 hr.		
Feces of bedbugs	" 1st 24 hr. after feeding	Nuttall	1899
Feces of Dermestes vulpinus	present	Proust	1894
BEETLES			
B. anthracis			
Intestinal tract of Blaps mucronata, Tentyria sp., Pimelia bifurcata, " sardea	present	Cao	1898
Surface	present		
Feces of Ptinus sp., Attagenus pellio, Anthrenus museorum	"	Matheson	1950
COCKROACHES			
B. anthracis			
Intestinal tract of Blatta orientalis	present	Cao	1898
Feces of Blatta orientalis	present	Kuster	1902
B. subtilis			
Feces of Blaberus cranifer	present	Wedberg	1949
B. cereus			
in Blaberus cranifer	present	Wedberg	1949
FLIES			
B. anthracis			
Stomach	present; transmitted		
Intestines of flies	" "	Bollinger	1874
Intestinal tract of Musca domestica, Calliphora vomitoria, Lucilia caesar, Sarcophaga carnaria	survived through life cycle and 9 d after maturity	Cao	1906
in Calliphora erythrocephala, Lucilia caesar	survived through life cycle and 15 d after maturity	Matheson	1950
in Tabanus striatus	exptl; present; transmitted	Mitzmain	1914
Gut	present; transmitted		
Feces of flies	" "	Schuberg	1912

TABLE 9 / (CONT'D) THE SURVIVAL OF BACILLUS SPECIES IN INSECTS

Factor(s)	Survival	Reference
FLIES (cont'd)		
B. anthracis (cont'd)		
in Musca domestica Calliphora erythrocephala	exptl; present; transmitted	
Feces of Stomoxys calcitrans	exptl; present; not transmitted; 72 hr.	Sen 1944
B. cereus		
Feces of Musca domestica	present	Hawley 1951
B. megatherium		
Feces of Musca domestica	present	Hawley 1951
TICKS		
B. anthracis		
in Argas persicus Intestines	present; transmitted indefinitely	Delpy 1937
Feces of Argas persicus	at least 100 d	Hindle 1925
Intestines of Boophilus decoloratus	24 hr.	Martinaglia 1932

TABLE 92 THE SURVIVAL OF BORRELIA SPECIES IN INSECTS

Factor(s)	Survival	Reference
BEDBUGS		
B. recurrentis		
in Cimex lectularis	exptl; present; not able to transmit by bite	Francis 1938
in Cimex lectularis	exptl; present; not able to transmit by bite	Rosenholz 1927
LICE		
B. recurrentis		
Tissues of Pediculus corporis	life of louse(19 d or more)	Chung 1936
in monkey louse - Pedicinus longiceps	exptl; present; not able to transmit	Francis 1938
Gut, ovaries, testis and malpighian tubules of Pediculus capitis and corporis	present	Mackie 1907
In lice	exptl; present; 18 d	Wolman 1945
B. persica		
Tissues of Pediculus corporis	present; transmitted	Adler 1942
REDUVIIDS		
B. duttonii		
Intestinal tract of Triatoma infestans	exptl; present; 6 d	Liem 1941
TICKS		
B. recurrentis		
in Ornithodoros turicata	present; transmitted	Burroughs 1944
Starved 5 yr. after an infective meal	exptl; 5 yr.; transmitted	
1 meal in 6½ yr. in Ornithodoros turicata	exptl; 6½ yr.; transmitted	Francis 1938
in Ornithodoros tholozani	present; transmitted	Gambles 1948
in " papillipes	" "	Pavlovskii 1945
in " tholozani	" "	Pavlovskii 1946
in " papillipes " tartakovskyi	exptl; 134 d; transmitted	Sofiev 1946
in " moubata " savignyi " talaje " rudis " turicata " hermsi " parkeri " erraticus " tholozani " tartakovskyi " nerensis	present; transmitted	Steinhaus 1947
in " turicata	present; transmitted	Weller 1930
in " turicata	present; transmitted	Wisseman 1945

TABLE 2 (CONT'D) THE SURVIVAL OF BORRELIA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
TICKS(cont'd)			
<u>B. duttonii</u>			
in Ornithodoros moubata	present; transmitted	Dutton	1905
in " "	present	Ross	1904
<u>B. duttonii var. crocidurae</u>			
in Ornithodoros erraticus	present; transmitted	Boiron	1949
<u>B. hispanica</u>			
in Ornithodoros erraticus	present; transmitted	Boiron	1948
in Rhipicephalus sanguineus	exptl; present	Seargent	1938
<u>B. anserina</u>			
in Argas persicus			
" reflexus			
Ornithodoros moubata	Present; transmitted	Steinhaus	1947
<u>B. theileri</u>			
in Margaropus decoloratus			
Rhipicephalus evertsi	present; transmitted	Steinhaus	1947

TABLE 3 THE SURVIVAL OF BRUCELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS Brucella spp. Feces of bedbugs	>3 mos.; not transmitted by bite	Tovar	1947
COCKROACHES B. abortus Intestinal tract of Periplaneta americana	24 hrs.	Ruhland	1941
FLEAS Brucella spp. Feces of fleas	present; not transmitted by bite	Tovar	1947
FLIES B. abortus in flies	24 hrs.	Patton	1931
Intestinal tract	>96 hrs.	Ruhland	1941
TICKS Brucella spp. Feces of ticks	>3 mos.; transmitted by bite and transmitted to eggs and larvae	Tovar	1947

TABLE 24 THE SURVIVAL CLOSTRIDIUM SPECIES IN INSECTS

Factor(s)	Survival	Reference
BEETLES		
C. tetani		
Feces	present	
of Blaps mucronata		
Tentyria sp.		
Pimelia bifurcata		
" sardea		Cao 1906
C. chauvoei		
Feces	present	
of Blaps mucronata		
Tentyria sp.		
Pimelia bifurcata		
" sardea		Cao 1898
C. sporogenes		
Feces	present	
of Blaps mucronata		
Tentyria sp.		
Pimelia bifurcata		
" sardea		Cao 1898
COCKROACHES		
C. tetani		
Feces	present	
of Blatta orientalis		Cao 1906
C. sporogenes		
Feces	present	
of Blatta orientalis		Cao 1898
C. chauvoei		
Feces	present	
of Blatta orientalis		Cao 1898

TABLE 5 THE SURVIVAL OF COLIFORM ORGANISMS IN INSECTS (ESCHERICHIA, PARACOLOBACTRUM & AEROBACTER)

Factor(s)	Survival	Reference	
BEETLES			
E. coli			
Feces	present		
of Blaps mucronata			
Tentyria sp.			
Pimelia bifurcata			
" sardea		Cao	1898
COCKROACHES			
E. coli			
Feces	present		
of Blatta orientalis		Cao	1898
Legs and feces	present		
of Blatta orientalis		Longfellow	1913
Intestinal tract	present		
of Blattella germanica		Steinhaus	1941
E. coli var. communior			
Feces	present		
of Blaberus cranifer		Wedberg	1949
E. freundii			
Feces	present		
of Blaberus cranifer		Wedberg	1949
E. spp.			
Hindgut	present; transmitted		
of Periplaneta americana		Bitter	1949
Paracolobactrum sp.			
Hindgut	present; transmitted		
of Periplaneta americana		Bitter	1949
Feces	present		
of Blaberus cranifer		Wedberg	1949
A. aerogenes			
Feces	present		
of Blaberus cranifer		Wedberg	1949
in cockroaches	present	Morrell	1911
A. cloacae			
in cockroaches	present	Morrell	1911
A. spp.			
Hindgut	present; transmitted		
of Periplaneta americana		Bitter	1949
FLIES			
E. coli			
Feces	present		
of Musca domestica			
Calliphora vomitoria			
Lucilia caesar			
Sarcophaga carnaria		Cao	1898
Intestines	present		
of Musca domestica		Cox	1912
Body	Inoc; fed a suspension of 12,000-48,000 organisms Recov: multiplied in body		
Feces	present		
of flies		Hawley	1948

TABLE 25 (CONT'D) THE SURVIVAL OF COLIFORM ORGANISMS IN INSECTS (ESCHERICHIA, PARACOLOBACTRUM & AEROBACTER)

Factor(s)	Survival	Reference	
FLIES (cont'd)			
E. coli (cont'd)			
Feces of Musca domestica	Inoc: 12,000-900,000 bacteria Recov: 1st d - 10-10,000 6th d - 1-200,000,000	Hawley	1951
Intestines of Musca domestica	present	Nicoll	1911
Intestines of Musca domestica	present	Scott	1917
Intestines of Musca domestica	present	Torrey	1912
E. coli var. communior			
Intestines of Musca domestica	present	Torrey	1912
Intestines of Musca domestica	present	Scott	1917
E. coli var. acidilactici			
Intestines of Musca domestica	present	Torrey	1912
Intestines of Musca domestica	present	Cox	1912
E. coli var. neopolitana			
Intestines of Musca domestica	present	Cox	1912
E. coli var. mutabilis			
Intestines of Musca domestica	present	Nicoll	1911
A. aerogenes			
External	Sanitary areas of city: 21,000-100,000/fly Unsanitary areas of city: 800,000-500,000,000/fly		
Internal of Musca domestica	Sanitary areas of city: 100-[illegible],000/fly Unsanitary areas of city: 10,000-333,000,000/fly	Cox	1912
Feces of Musca domestica	present	Hawley	1951
Intestines of Musca domestica	present	Nicoll	1911
Intestinal tract of Musca domestica	present	Torrey	1912
Colon group			
Internally and externally of Musca domestica	Recov: 100,000 human faecal bacteria in a single fly	Graham-Smith	1909

TABLE 26 THE SURVIVAL OF CORYNEBACTERIUM SPECIES IN INSECTS

Factor(s)	Survival	Reference
BEETLES		
<u>C. pseudodiphthericum</u>		
Intestinal tract	present	
Tentyria sp.		
Blaps mucronata		
Pimelia bifurcata		
" sardea		Cao 1898
COCKROACHES		
<u>C. pseudodiphthericum</u>		
Intestinal tract	present	
of Blatta orientalis		Cao 1898
<u>C. diphtheriae</u>		
Legs and feces	present	
of Blata orientalis		Longfellow 1913
FLIES		
<u>C. diphtheriae</u>		
Legs and wings	exptl; few hrs.	
Intestines	" > 24 hrs.	
Feces	" 51 hrs.	
of Musca domestica		
Calliphora erythro-cephala		Graham-Smith 1910
Intestinal tract	exptl; 24 hrs.	
of flies		Graham-Smith 1913

TABLE 27 THE SURVIVAL OF DIPLOCOCCUS & STREPTOCOCCUS SPECIES IN INSECTS

Factor(s)	Survival	Reference
COCKROACHES		
Diplococcus pneumoniae		
Legs and feces of Blatta orientalis	present	Longfellow 1913
Streptococcus faecalis		
Alimentary tract of Blattella germanica	present	Steinhaus 1941
FLEAS		
Diplococcus pneumoniae		
Intestinal tract of fleas	present	Pinto 1930
FLIES		
Streptococcus faecalis		
Intestinal tract of Musca domestica	present	Cox 1912
Intestinal tract of Musca domestica	present	Scott 1917
Intestinal tract of Musca domestica	present	Torrey 1912
Streptococcus equinus		
Intestinal tract of Musca domestica	present	Torrey 1912
Streptococcus sp.		
in flies	present	Schuberg 1914
Streptococcus pyogenes		
in Musca domestica	present	Scott 1917
Externally of flies	present	Shooter 1944
Streptococcus agalactiae		
in Musca domestica	present	Ewing 1942
in " "	present	Saunders 1904
LICE		
Diplococcus pneumoniae		
F[illegible]s [illegible] Pediculus capitis	24 hrs.	Pierce 1921
REDUV[illegible]		
Stre[illegible]occus faecalis		
in Triatoma infestans	present; transmitted	Brecher 1944

TABLE 28 THE SURVIVAL OF FUNGI, YEASTS & MOLDS IN INSECTS

Factor(s)	Survival	Reference	
COCKROACHES			
<u>Rhizopus nigricans</u>			
<u>Penicillium spp.</u>			
<u>Saccharomyces cerevisiae</u>			
<u>Actinomyces spp.</u>			
<u>Molds</u>			
<u>Yeasts</u>			
Feces of Blaberus cranifer	yes	Wedberg	1949
<u>Torula rosea</u> (yeast) Feces of Blaberus cranifer	exptl; Inoc: massive doses Recov: present 6 d	Wedberg	1949
<u>Torula sp.</u> in Periplaneta americana	present; transmitted	Owen	1948

TABLE 19 THE SURVIVAL OF MALLEOMYCES MALLEI IN INSECTS

Factor(s)	Survival	Reference
BEETLES		
<u>M. mallei</u>		
Feces	present	
of Blaps mucronata		
Tentyria sp.		
Pimelia bifurcata		
" sardea		Cao 1898
COCKROACHES		
<u>M. mallei</u>		
Feces	present	
of Blatta orientalis		Cao 1898
FLEAS		
<u>M. pseudomallei</u>		
Body	50 d; transmitted	
Feces	present; transmitted	
of Xenopsylla cheopis		Blanc 1941
in rat fleas	exptl; present; transmitted	Blanc 1942
MOSQUITOES		
<u>M. pseudomallei</u>		
in Aedes egypti	exptl; present; transmitted	Blanc 1942

TABLE 210 THE SURVIVAL OF MICROCOCCUS SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEETLES			
M. albus			
Intestinal tract of Melolontha vulgaris	present	Cao	1906
M. aureus			
Intestinal tract of Melolontha vulgaris	present	Cao	1906
M. citreus			
Intestinal tract of Melolontha vulgaris	present	Cao	1906
COCKROACHES			
M. albus			
in Blattella germanica	present	Herms	1939
in Blaberus cranifer	present	Wedberg	1949
M. aureus			
Antennae, feet and stomach of Blattella germanica	present	Herms	1939
Legs and feces of Blatta orientalis	present	Longfellow	1913
Feces of Blaberus cranifer	present	Wedberg	1949
M. citreus			
Legs and feces of Blatta orientalis	present	Longfellow	1913
FLIES			
M. albus			
External of flies	present	Scott	1917
External of flies	present	Torrey	1912
in tabanid flies	present	Joly	1898
M. aureus			
Feces of Musca domestica	present	Celli	1888
Feces of Musca domestica	present	Hawley	1951
in tabanid flies	present	Joly	1898
Feet of flies	present	Scott	1917
M. aureus, 611			
Gut	8 d		
Feces	3-5 d	Moorehead	1946
M. citreus			
Body and feces of flies	survived through life cycle and 9 d after maturity	Scott	1917
M. spp.			
in Musca domestica	present	Cox	1912
Sarcina lutea			
Feces of Musca domestica	present	Hawley	1951
LICE			
M. pemphigicontagiosa			
in Pediculus capitis	present; transmitted	Dewevre	1892

TABLE 10 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES IN INSECTS

Factor(s)	Survival	Reference
LICE (cont'd)		
M. spp.		
in Pediculus capitis	present	Pierce 1921
MOSQUITOES		
M. aureus		
Gut of Aedes egypti	at least 24 hr.; not after 7 d	St. John 1930
TICKS		
M. aureus		
in Argas reflexus	present	Galli-Valerio 1907

TABLE Q 11 THE SURVIVAL OF MICROORGANISMS IN INSECTS

Factor(s)	Survival	Reference
BEETLES		
Klebsiella pneumoniae		
Feces	present	
of Blaps mucronata		
Tentyria sp.		
Pimelia bifurcata		
" sardea		Cao 1898
COCKROACHES		
Klebsiella pneumoniae		
Feces	present	
of Blatta orientalis		Cao 1898
Proteus vulgaris		
Hindgut	present; transmitted	
of Periplaneta americana		Bitter 1949
Legs and feces	present	
of Blatta orientalis		Longfellow 1913
Feces	present	
of Blaberus cranifer		Wedberg 1949
Proteus morganii		
Proteus mirabilis		
Proteus rettgeri		
Hindgut	present; transmitted	
of Periplaneta americana		Bitter 1949
Pseudomonas aeruginosa		
Hindgut	present; transmitted	
of Periplaneta americana		Bitter 1949
Feces	present	
of Blaberus cranifer		Wedberg 1949
Serratia marcescens		
Feces	exptl; duration of life	
of Blaberus cranifer	of roach	Wedberg 1949
FLIES		
Neisseria gonorrhoeae		
Feet	3 hrs.	
of flies		Matheson 1950
Neisseria meningitidis (intracellularis)		
in flies	present	MacGregor 1917
Proteus vulgaris		
Feces	present	
of Mucsa domestica		
Calliphora vomitoria		
Lucilia caesar		
Sarcophaga carnaria		Cao 1906
in Musca domestica	present	Scott 1917
Proteus morganii		
Feces	present	
of Musca domestica		Hawley 1951
in Musca domestica	present	Morgan 1909
Intestines	present	
of Musca domestica		Nicoll 1911
in Musca domestica	present	Cox 1912

TABLE 11 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN INSECTS

Factor(s)	Survival	Reference
FLIES (cont'd)		
<u>Pseudomonas aeruginosa</u>		
Intestinal tract of Musca domestica	survives through metamorphosis; transmitted	Bacot 1911
Feces of Musca domestica, Calliphora vomitoria, Lucilia caesar, Sarcophaga carnaria	present; survived through the life cycle	Cao 1898
Gut of Stomoxys calcitrans	present	Duncan 1926
Intestinal tract of flies	present; survives through metamorphosis	Ledingham 1911
<u>Pseudomonas sp.</u>		
Feces of Musca domestica	present	Hawley 1951
<u>Serratia marcescens</u>		
Crop	exptl; large numbers recovered; 4-5 d	
Intestines of Musca domestica	exptl; present; up to 18 d	Graham-Smith 1913
Pupae of Musca domestica	1 d	Ledingham 1911

TABLE 4/2 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN INSECTS

Factor(s)	Survival	Reference
BEDBUGS		
M. leprae		
Intestinal tract of Cimex lectularis	present	Long 1911
Proboscis	5 d	
Intestinal tract	16 d	
Feces of bedbugs	present	Matheson 1950
BEETLES		
M. tuberculosis		
Intestinal tract of Tentyria sp.	present	
Blaps mucronata		
Pimelia bifurcata		
" sardea		Cao 1898
COCKROACHES		
M. tuberculosis		
Intestinal tract of Blatta orientalis	present	Cao 1898
Feces of Blatta orientalis	present	Kuster 1902
Feces of Periplaneta americana	present	Macfie 1922
Feces of Periplaneta americana	2-5 d; transmitted	Riley 1932
Feces of cockroaches	present	Tejira 1926
M. leprae		
Feces of Periplaneta americana	present	Macfie 1922
Gut	exptl; multiplied	
Feces - dried of cockroaches	" 169 d	Moiser 1945
Intestines of cockroaches	present	Riley 1932
in cockroaches	present	Tejira 1926
FLEAS		
M. leprae		
Stomach of fleas	present	Munoz-Rivas 1946
FLIES		
M. tuberculosis		
Intestines and feces of Musca domestica	present; transmitted	Andre 1908
Intestinal contents and feces of Musca domestica	present	Celli 1888
Intestines and feces of flies	exptl; 13 d	Graham-Smith 1913
Intestines and feces of Musca domestica	present	Hofmann 1888
Intestines and feces of flies	present	Spielman 1887

TABLE 2/2 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN INSECTS

Factor(s)	Survival	Reference	
FLIES (CONT'D)			
M. leprae			
Intestinal tract and feces of Musca domestica	several days		
Sarcophaga pallinervis			
Sarcophaga barbata			
Volencelle obesa			
Lucilia sp.		Currie	1910
in Stomoxys calcitrans			
Musca domestica	present	Honeij	1914
LICE			
M. leprae			
in Pediculus capitis	present	McCoy	1912
MOSQUITOES			
M. leprae			
in Aedes egypti	present	Riley	1938
Gut of Aedes egypti	at least 24 hr., not after 7 d	St. John	1930

TABLE 9/13 THE SURVIVAL OF PASTEURELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
P. tularensis			
in Cimex lectularis	136 d	Bozhenko	1935
Excrement of Cimex lectularis	exptl; infective; present	Davis	1943
in Cimex lectularis	present	Francis	1927
in " "	exptl; present; transmitted	Francis	1922
in bedbugs	present	Kamil	1936
FLEAS			
P. pestis			
Alimentary tract of fleas	greatly multiplied; transmitted	Bacot	1914
Live	21 d; transmitted		
Dead	5 d; "		
Excreta of Pulex irritans	5 d; "	Blanc	1941
in Xenopsylla cheopis, Nosophyllus fasciatus, Orchopeas sexdentatus sexdentatus, Opisodasys nesiotus, Megabothris abantis, Malareus telchinom, Diamanus montanus, Echidnophaga gallinacea	present, transmitted	Burroughs	1947
Alimentary tract	present		
Feces of fleas	present in very small numbers	Douglas	1943
Feces- dried of fleas	4 wk.; exptl.; transmitted	Eskey	1938
Feces-dried, 66F. of fleas	5 wk.; exptl.; transmitted	Eskey	1939
in fleas	Inoc: approx.5,000 bacteria taken in at a blood meal Recov; multiplied Epidemic- 15 d Nonepidemic- 7 d	Herms	1950
in Xenopsylla cheopis	Present; transmitted	Lien-teh	1936
in fleas	" "	Liston	1905
in Diamanus montanus, Hoplopsyllus anomalus	present; transmitted	Meyer	1949
in fleas	exptl; present; survive through hibernation	Prince	1947
in fleas			
50F., RH - saturated	present; favorable conditions for survival		
>80F., RH- dry	present; adverse conditions for survival	Topley	1932

TABLE 9-13 (CONT'D) THE SURVIVAL OF PASTEURELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
FLEAS(cont'd)			
P. tularensis			
in Spilopsyllus cuniculi	present; transmitted	Green	1938
Tissues of fleas	present	McCoy	1911
in Ctenocephalus pallex			
" orientalis	present; transmitted	Volferz	1934
in Cediopsylla simplex	" "	Waller	1940
FLIES			
P. tularensis			
in Chrysops discalis	present; transmitted	Francis	1921
in horse-fly, stable-fly and rainfly	present	Olsofiev	1936
LICE			
P. tularensis			
in lice	present; transmitted	Davis	1935
in Haemodipus ventricosus	" "	Francis	1922
in Polyplex serratus	" "	Franzis	1922
MITES			
P. tularensis			
in Bdellonyssus bacoti	exptl; present, transmitted	Hopla	1951
in Gamasidae	present, transmitted	Volferz	1934
MOSQUITOES			
P. tularensis			
Feces of Culex apicalis	present	Bozhenko	1936
in Aedes cinereus	present	Olin	1942
in mosquitoes	present	Olsofiev	1936
Intestines and feces of Aedes nearticus	present; transmitted		
" vexans			
" dorsalis			
" stimulans			
" caradensis			
Theobaldi inddcens			
Culex tarsalis		Philip	1932
TICKS			
P. pestis			
in Hyalomma volgense			
P. schulze			
E. schlottke	present; transmitted	Borzenkov	1933
in Argas persicus	" "	Foddeeva	1932
Tissues of ticks	" "	Lien-teh	1936
Tissues of ticks	" "	Matheson	1950
P. tularensis			
Tissues of ticks	Present; transmitted	Davis	1940
Tissues	exptl; not transmitted during feeding		
Ornithodoros turicata	674 d		
" parkeri	701 d	Davis	1940

TABLE 2/8 (CONT'D) THE SURVIVAL OF PASTEURELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
TICKS (cont'd)			
<u>P. tularensis</u> (cont'			
in Ixodes ricinus			
" californicus	present	Davis	1937
Feces of Dermacentor andersoni	present; transmitted	Francis	1927
in ticks	" "	Matheson	1950
in Dermacentor variabilis	" "	Green	1931
in Ornithodoros lahorensis	" "	Kamil	1938
in Dermacentor occidentalis	" "	Parker	1929
in Dermacentor andersoni	survived life cycle	Parker	1924
in Dermacentor variabilis	stage to stage and generation to generation survival	Philip	1934

TABLE 2/4 THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
Trypanosoma cruzi in Cimex pilosellus	exptl; present; transmitted	Wood	1951
COCKROACHES			
Endamoeba histolytica			
Hindgut and feces of Periplaneta americana	exptl; cysts present for 72 hr.	Frye	1936
Feces of Periplaneta americana	cysts present	Macfie	1922
Giardia lamblia			
in Periplaneta americana	cysts present	Macfie	1922
Colonic contents of cockroaches	exptl; 12 d	Young	1937
Anclyostoma duodenale			
" ceylanicum			
Necator americanus			
Ascaris lumbricoides			
Trichuris trichura			
Taenia saginata			
Schistosoma haemotobium			
Feces of Periplaneta americana	eggs present	Macfie	1922
FLIES			
Chilomastix mesnili			
Feces of Musca domestica	cysts present	Root	1921
Endamoeba histolytica			
Intestinal contents of Chrysomyia megacephala, Lucilia sericata, Sarcophaga spp.	cysts present	Chang	1943
in Musca domestica	cysts present	Frye	1932
in flies	" "	Harris	1946
Dejecta	trophozoites present		
" of Musca domestica, Lucilia pallescens, Cochliomyia macellaria, Phormia regina, Sarcophaga miserio	cysts recovered 154-258 minutes; exptl.	Pipkin	1943
	exptl; troph. / cysts		
Crop	40 min. / 210 min.		
Midgut	30 " / 240 "		
External surface	4 "		
Rectum	210 "		
Vomit drop	17 " / 64 "		
Faecal drop of flies	254 "	Pipkin	1949
Feces of Musca domestica	exptl; cysts present	Root	1921
Feces of Musca domestica	" " "	Roubaud	1918
Feces of Musca domestica	" " "	Sieyro	1942

TABLE 914 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference	
FLIES (cont'd)			
Endamoeba histolytica (cont'd)			
Feces and intestinal tract	cysts present		
" " " " of Musca domestica	exptl; cysts present; 2-3 d	Matheson	1950
Endamoeba coli			
in Musca domestica	cysts present	Frye	1932
Feces of Musca domestica	exptl; cysts present	Root	1921
Feces of Musca domestica	" " "	Roubaud	1918
Feces and intestinal tract	cysts present		
" " " " of Musca domestica	exptl; cysts present, 2-3 d	Matheson	1950
Endolimax nana			
in Musca domestica	cysts present	Frye	1932
Giardia lamblia			
Feces of Musca domestica	cysts present	Root	1921
Feces of Musca domestica	cysts present	Roubaud	1918
Feces and intestinal tract	cysts present		
" " " " of Musca domestica	exptl; cysts present, 2-3 d	Matheson	1950
in flies	cysts present	Frye	1932
Leishmania braziliensis			
in Phlebotomus lutzi " intermedius	present, transmitted	Steinhaus	1947
Leishmania donovani			
in Phlebotomus argentipes	exptl; present; transmitted	Napier	1933
Gut of Phlebotomus argentipes	present	Matheson	1950
Gut of Phlebotomus major var. chinensis Phlebotomus sergenti	present	Patton	1927
in Phlebotomus argentipes	exptl; present; transmitted	Matheson	1950
in Phlebotomus argentipes	exptl; present; transmitted	Smith	1936
in Phlebotomus argentipes " perniciosus major longicuspis major var. chinensis	present; transmitted	Steinhaus	1947
in Phlebotomus argentipes	exptl; present; transmitted	Swanimath	1942
Gut of Phlebotomus spp.	present	Young	1927

TABLE 9/14 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference
FLIES (cont'd)		
Leishmania tropica		
in Phlebotomus papatasii	present; transmitted	Adler 1941
in " sergenti	" "	Adler 1929
in " papatasii " sergenti	" "	Adler 1948
in " papatasii " sergenti	" "	Steinhaus 1947
Trypanosoma rhodesiense		
in Glossina brevipalpis " morsitans	present; transmitted	Matheson 1950
in Glossina morsitans	" "	Kinghorn 1912
in " " " swynnertoni	present; transmitted	Steinhaus 1947
in " palpalis " brevipalpis	exptl; present; transmitted	Steinhaus 1947
Trypanosoma gambiense		
Proboscis of Glossina palpalis	<48 hrs; transmitted	Bruce 1903
in Glossina palpalis	present; transmitted	Castellani 1903
in " "	" "	Kleine 1909
in " "	multiplied; duration of life; transmitted	Robertson 191[illegible]
in Glossina tachinoides	present; transmitted	Steinhaus 1947
in " morsitans " fusca " pallidipes " submorsitans	exptl; present; transmitted	Steinhaus 1947
Trypanosoma brucei		
in Glossina morsitans	present; transmitted	Kleine 1909
Ascaris lumbricoides		
Intestinal tract of Chrysomyia megacephala Lucilia sericata Sarcophaga spp.	ova present	Chang 1943
Externally of Musca domestica Lucilia pallescens Cochliomyia macellaria Phormia regina Sarcophaga miserio	exptl; eggs present	Pipkin 1943
Enterobius vermicularis		
Externally of Musca domestica Lucilia pallescens Cochliomyia macellaria Phormia regina Sarcophaga miserio	exptl; eggs present	Pipkin 1943

TABLE 2/4 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference
FLIES (cont'd)		
Hookworms - spp. not given		
Intestinal contents	ova present	
of Chrysomyia megacephala		
Lucilia sericata		
Sarcophaga spp.		Chang 1943
Hookworm - Necator americanus		
Externally	exptl; eggs present	
of Musca domestica		
Lucilia pallescens		
Cochliomyia macellaria		
Phormia regina		
Sarcophaga miserio		Pipkin 1943
Trichuris trichura		
Intestinal contents	ova present	
of Chrysomyia megacephala		
Lucilia sericata		
Sarcophaga spp.		Chang 1943
Externally	exptl; eggs present	
of Musca domestica		
Lucilia pallescens		
Cochliomyia macellaria		
Phormia regina		
Sarcophaga miserio		Pipkin 1943
LICE		
Trypanosoma duttoni		
in Pediculus corporis	present; transmitted	Heisch 1949
MOSQUITOES		
Plasmodium flaciparum		
in Anopheles albimanus	present; transmitted	Eyles 1949
Over 68F, opt. 86F	" "	
RH - near 70%		
in mosquitoes		Gill 1938
in Anopheles quadrimaculatus		
Anopheles albimanus	exptl; present; transmitted	Jeffery 1950
35F	24 hrs.	
in Anopheles quadrimaculatus		King 1917
Over 68F, opt. 86F		
RH at least 70%	present; transmitted	
in mosquitoes		Matheson 1950
Plasmodium malarie		
in Anopheles maculipennis	exptl; present; transmitted	Young 1947

TABLE 2/4 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference
MOSQUITOES (cont'd)		
Plasmodium vivax		
in Anopheles quadrimaculatus	exptl; present; transmitted	Eyles 1948
Mean temp. between 60.8-68F; RH - not below 70% in mosquitoes	present; transmitted	Gill 1938
in Anopheles maculipennis	infective for nearly 6 mos.	James 1927
4-6C	infective for 2½ yrs.	
in Anopheles maculipennis		Matheson 1950
30F	2 d	
31F	4 d	
46F	17 d	
in Anopheles quadrimaculatus		King 1917
Over 62F, opt. 77F RH over 70%	present	
in mosquitoes		Matheson 1950
19-22.8C	exptl; present; transmitted	
in mosquitoes		Matheson 1933
in Anopheles maculipennis freeborni Anopheles maculipennis occidentalis Anopheles punctipennis	exptl; present; transmitted	Moore 1945
in Anopheles barberi	exptl; present; transmitted	Stratman-Thomas 1936
in Anopheles quadrimaculatus	exptl; present; transmitted	Watson 1945
in Anopheles quadrimaculatus	exptl; present; transmitted	Young 1952
in Anopheles quadrimaculatus Anopheles maculipennis freeborni	exptl; present; transmitted	Young 1945
Plasmodium spp.		
in mosquitoes	present; transmitted	Bastianelli 1898
in mosquitoes	" "	Manson 1898
Salivary glands 59-83F for 6 d 44-78F for remainder of time Diet - date juice & H_2O	68-92 d	
in Anopheles punctipennis		Mayne 1922

TABLE 2/14 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference
MOSQUITOES (cont'd)		
Plasmodium spp. (cont'd)		
in mosquitoes	present	Ross 1898
in mosquitoes	"	Sambon 1900
in Anopheles quadrimaculatus		
Anopheles maculipennis		
" crucians		
" albimanus		
" pseudopunctipennis		
" tarsimaculatus		
" argyritarsis		
" darlingi		
" albitarsis		
" punctimacula		
" hectoris		
" bellator	present, transmitted	Simmons 1941
Tryp[illegible]a gambi[illegible]		
[illegible] Mansonia uniformis	exptl; present; transmitted	Steinhaus 1947
Wuchereria bancrofti		
in Culex quinquefasciatus		
" annulirostris	exptl; present; transmitted	Cobrera 1951
in Culex fatigans	present; transmitted	Carter 1948
in Culex pipiens		
" quinquefasciatus	present; transmitted	Eyles 1947
in Culex pipiens		
Psorophora discolor	exptl; present; transmitted	Newton 1946
Wuchereria malayi		
in subgroup Mansonioides spp.		
Anopheles byrcanus	present; transmitted	Carter 1948
Filaria sanguinis hominis		
in Culex fatigans	present	Ross 1898
REDUVIIDS		
Leishmania donovani		
in Triatoma spp.	exptl; no multiplication; 1 d	Packchanian 1948
Leishmania tropica		
in Triatoma spp.	exptl; no multiplication; 1 d	Packchanian 1948
Trypanosoma cruzi		
Feces	present; transmitted	
of Rhodnius prolixus		Brumpt 1912
in Triatoma megista	" "	Chagas 1909
in " sanguisuga	" "	Elkins 1951
in Rhodnius prolixus		
" pictipes	" "	Floch 1947
in Triatoma protracta	" "	Kofoid 1933

TABLE 314 (CONT'D) THE SURVIVAL OF PROTOZOA & METAZOA IN INSECTS

Factor(s)	Survival	Reference
REDUVIIDS (cont'd)		
Trypanosoma cruzi (cont'd)		
in Triatoma megista		
" infestans		
" sordida		
" dimidiata		
" heidemanni		
" gerstaeckeri		
" sanguisuga		
" chazasi		
" geniculata		
" hegneri		
" vitticeps		
" longipes		
" rubida		
Rhodnius prolixus		
" pictipes		
Eratyrus cuspidatus	present; transmitted	Steinhaus 1947
in Triatoma gerstaeckeri		
" lectularis		
" protracta		
" sanguisuga		
" nectomae		
" rubida	present; transmitted	Sullivan 1949
in Triatoma protracta	" "	Wood 1934
in Triatoma protracta		
" rubida		
" longipes		
dead for 15 days	present; transmitted	Wood 1942
in Triatoma heidemanni	" "	Wood 1943
in Triatoma protracta	" "	Wood 1950
Trypanosoma gambiense		
in Triatoma spp.	exptl; present; 4-6 d	Packchanian 1948
Trypanosoma brucei		
in Triatoma spp.	exptl; present; 4-6 d	Packchanian 1948
Trypanosoma duttonii		
in Triatoma gerstaeckeri	exptl; no multiplication; 2-3 d	Packchanian 1948
TICKS		
Babesia bigemina		
in Boophilus annulatus	present; transmitted	Dennis 1931
in " "	" "	Dennis 1932
in " "	" "	Smith 1893
Babesia bovis		
in Ixodes ricinus	present; transmitted	Steinhaus 1947
Leishmania donovani		
Gut of ticks	exptl; 25 d; transmitted	Feng 1949
Trypanosoma cruzi		
in Ornithodoros furcosus		
" parkeri		
" amblus	present; many wks. or mos.	Steinhaus 1947

TABLE 8/2 THE SURVIVAL OF RICKETTSIA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
R. typhi			
in Cimex lectularis	exptl; not transmitted; 10 d	Castaneda	1930
R. rickettsi			
in Cimex lectularis " rotundatus	exptl; 24 hrs.; present	Steinhaus	1947
R. prowazeki			
Coelomic cavity of bedbugs	present; harbors but does not transmit	Nauck	1941
FLEAS			
R. typhi			
in Echidnophaga gallinacea	exptl; present; transmitted	Olicata	1942
in " "	present; transmitted	Brigham	1941
Tissues of fleas	at least 52 d; transmitted	Dyer	1932
in Xenopsylla cheopis	present	Dyer	1931
in Ctenocephalus felis	present; transmitted	Irons	1944
in Xenopsylla cheopis Ceratophyllus anisus	present; transmitted	Liu	1944
Feces of Xenopsylla cheopis	<96 hrs.; transmitted	Rickard	1951
in Xenopsylla cheopis	present; transmitted	Savoor	1948
in fleas	exptl; present	Weyer	1949
R. prowazeki			
in Xenopsylla cheopis	exptl; present	Dyer	1934
in fleas	" "	Weyer	1949
LICE			
R. typhi			
in Pediculus corporis	present; transmitted	Liu	1944
in Polyplax spinulosus	" "	Mooser	1931
in Pediculus corporis	exptl; present; transmitted	Mooser	1930
in Pedic[illegible]oris	exptl; present; 10 d	Snyder	194[illegible]
R. prow[illegible]			
Excreta - dry, room temp.	11-12 d	Arkwright	1923
in Pediculus capitis " corporis	present; transmitted	Atkin	1922
in Pedicinus albidus	exptl; present; transmitted	Blanc	1945
in Pediculus corporis	exptl; present; transmitted	Cabasso	1947
Gut >32C	exptl; present; transmitted		
23C of lice	exptl; did not survive	DaRocha	1916
in lice	exptl; present	Mariani	1940
in Pediculus capitis " corporis	exptl; present; transmitted	Nicolle	1909

TABLE 215 (CONT'D) THE SURVIVAL OF RICKETTSIA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
LICE (cont'd)			
R. prowazeki (cont'd)			
Feces - room temp.	60 d		
of Pediculus capitis			
" corporis		Nuttall	1917
in Pediculus vestimenti	present; transmitted	Ricketts	1910
Feces			
RH - high RH hastened disappearance of rickettsia in feces	8-9 d (guinea pig test) 19-147 d (louse test)		
of lice		Shu-Hsian	1949
Intestines - dried at			
normal pressure	58 d		
dried at low pressure	35 d		
Feces	66 d		
lice - dried with chloride	21 d		
dead lice - which lived			
under normal conditions	7 d	Starzok	1936
R. wolhynica			
lice	exptl; present		
dried feces	" " 2½ yrs.	Weyer	1948
R. quintana			
Gut and feces	present; transmitted		
of Pediculus corporis		Hindle	1921
in Pediculus corporis	present; 4 mos.	Steinhaus	1947
Stomach lumen	present		
of lice		Toepfer	1916
MITES			
R. typhi			
in Liponyssus bacoti	present; transmitted	Dove	1931
in Schongastia indica			
Family Trombiculidae	present; transmitted	Gispen	1950
in Liponyssus nagayoi	" "	Kodama	1933
in " bacoti	" "	Liu	1944
in " "	" "	Liu	1947
in " "	" "	Pang	1941
R. tsutsugamushi			
in mites	present; transmitted	Kawamura	1931
in mites	" "	Kitashima	1918
in Trombicula fletcheri			
" walchi	" "	Kohls	1945
in " deliensis			
larvae	exptl; present; transmitted	Krishman	1949
in Trombicula deliensis	present; transmitted	Krishman	1949
in " "			
hatched eggs	present; transmitted	Mackie	1946
in mites	" "	Miyajima	1917
in mites	present	Philip	1945
in Trombicula akamushi			
" deliensis	present; transmitted	Steinhaus	1947
in mites	" "	Tanaka	1899
in Euschongastia indica	" "	Traub	1950

TABLE 9/5 (CONT'D) THE SURVIVAL OF RICKETTSIA SPECIES IN INSECTS

Factor(s)	Survival	Reference
MITES (cont'd)		
<u>R. akari</u>		
in Allodermanyssus sanguineus	present	Huebner 1946
in Liponyssus bacoti	exptl; present; transmitted	Philip 1948
in [illegible] "	exptl; present; transmitted	Phillip 1948
TICKS		
<u>R. typhi</u>		
in Ornithodoros moubata	exptl; present	Weyer 1948
in Dermacentor andersoni, Otocenter nitens, Amblyomma sp.	exptl; present; 12 d	Zinsser 1931
<u>R. rickettsi</u>		
in Rhipicephalus sanguineus	present; transmitted	Anigstein 1943
in Dermacentor andersoni	" "	Davis 1939
in " variabilis	present; transovarian transmission	Dyer 1931
in " andersoni, " variabilis, Haemaphysalis leporis-palustris, Amblyomma americanum	present; transmitted	Parker - Unpublished expt.
in Dermacentor occidentalis, Rhipicephalus sanguisuga	transovarian transmission; survives winter in infected nymphal or adult ticks; at end of winter organism is non-symptom producing until its level of virulence is raised, either by heat or ingestion of blood	Parker 1937
in Otocentor nitens, Dermacentor andersoni, Ornithodoros parkeri, " rudis, " turicata	present; transmitted	Patino-Camargo 1941
All tissues of Dermacentor andersoni	present; transmitted	Steinhaus 1947
in ticks	present; transmitted	Badger 1932
in Amblyomma cajennense	" "	Bustamente 1946
in Rhipicephalus sanguineus	" "	Bustamente 1946
in Rhipicephalus sanguineus	present	Mariotte 1944
in Ornithodoros furcosus	exptl; 345 d	Mazzotti 1946

TABLE 2/5 (CONT'D) THE SURVIVAL OF RICKETTSIA SPECIES IN INSECTS

Factor(s)	Survival	Reference
TICKS (cont'd)		
R. rickettsi (cont'd)		
in Haemaphysalis leporis-palustris	present; transmitted	Parker 1923
in Haemaphysalis leporis-palustris	present; transmitted	Parker 1951
in Dermacentor andersoni	" "	Ricketts 1906
RMSF-like rickettsia		
in Rhipicephalus sanguineus	present; transmitted	Bustamente 1947
in Rhipicephalus sinus Haemaphysalis leachi	" "	Dick 1947
in Amblyomma maculatum	" "	Lackman 1949
in " "	" "	Parker 1940
in " "	" "	Parker 1939
in " striatum (Mexican spotted fever)	exptl; present; transmitted	Vallejo-Freire 1947
in Ornithodoros rudis (Tobia petechial fever)	exptl; 11 & 35 d	Parker 1942
in Ornithodoros parkeri (Tobia petechial fever)	exptl; 1,087 d	Patino-Camargo 1944
R. prowazeki		
in Ornithodoros moubata	exptl; present; 262 d	Weyer 1948
R. wolhynica		
in Ornithodoros moubata	exptl; present; 69 d	Weyer 1948
R. conori		
in Rhipicephalus sanguineus	>18 mos.; transmitted	Brumpt 1932
Nearly all tissues in Rhipicephalus sanguineus	present	Hass 1936
in Ornithodoros moubata	exptl; >36 d	Parker 1942
in Rhipicephalus sanguineus	survives through life cycle	Steinhaus 1947
Bullis fever rickettsia		
in Amblyomma americanum	present	Pollard 1946
Coxiella burneti		
in Hymlomma mauritanicum	present; transmitted	Blanc 1949
in " savignyi	" "	Blanc 1946
in Dermacentor occidentalis Amblyomma americanum	" "	Cox 1940
in Dermacentor andersoni	" "	Davis 1939
Tissues and feces of Rhipicephalus sanguineus	exptl; present; transmitted	Callot 1950
in Ornithodoros moubata	exptl; infective 428 d persists 670 d	
Ornithodoros hermsi	" infective 772 d persists 979 d transmitted by both	Davis 1943

TABLE 9/15 (CONT'D) THE SURVIVAL OF RICKETTSIA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
TICKS (cont'd)			
Coxiella burneti (cont'd)			
in Dermacentor andersoni	present	Matheson	1950
in Haemephysalis leachi	present; transmitted	Giroud	1950
in Ornithodoros moubata	4 mos.	Jadin	1950
in Otobius megnini	present	Jellison	1948
in Dermacentor andersoni	present; transmitted	Parker	1938
in Hyalomma savignyi	present	Parker	1939
in Amblyomma americanum	present	Parker	1943
in Phipicephalus sanguineus	present	Parker	1949
Feces - dried of ticks	viable in storage as long as 586 d	Philip	1948
in Haemaphysalis humerosa	present; transmitted	Smith	1940

TABLE 16 THE SURVIVAL OF SALMONELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
S. paratyphi			
Stomach of Cimex lectularis	exptl; 2-3 wks.; not transmitted	Caspari	1939
COCKROACHES			
S. typhosa			
Body and feet of Periplaneta orientalis	present; transmitted	Antonelli	1930
Feces of cockroaches	present	Riley	1932
S. typhimurium			
Intestinal tract Appendages of Periplaneta americana	present	Beck	1943
Feces Alimentary canal of cockroaches	Inoc: 4-10 million exptl; 11 d " 7 d	Janssen	1952
Feces of Blaberus cranifer	exptl; Inoc: massive doses 12 d	Wedberg	1949
S. paratyphi B			
in Periplaneta americana	present; transmitted	Bitter	1949
S. oranienburg			
in Periplaneta americana	present; transmitted	Bitter	1949
Feces of Periplaneta americana	Inoc: 100 million 10 d		
Feces of Blattella germanica	Inoc: 100 million 12 d		
Tissues	Inoc: 100 million; 42 d		
Feces of Blatta orientalis	" " " 20 d	Olson	1950
S. bredeney			
Hindgut of Periplaneta americana	present; transmitted	Bitter	1949
S. bovis-morbificans			
Appendages Intestinal tract of cockroaches	present	Mackerras	1948
S. spp.			
Intestinal tract Appendages	18-42 d	Mackerras	1948
FLEAS			
S. enteritidis			
Body and feces of Xenopsylla cheopis	exptl; present; transmitted	Eskey	1949
Body	exptl; 96 hr.; transmitted		
Feces of Pulex irritans Ctenocephalus canis	exptl; <24 hr.; transmitted	Varela	1946

TABLE 316 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference
FLEAS (cont'd)		
S. choleraesuis		
in Pulex irritans	present; transmitted	Messerlin 1942
FLIES		
S. typhosa		
in flies	present	Bahr 1914
in flies	"	Bertarelle 1910
Feces	"	
of Musca domestica		Celli 1888
in flies	"	Cochrane 1912
Legs	exptl; present	
Feces	" greater trans-	
of flies	mission than legs; 16d	Faichnie 1909
Intestinal tract	multiplied	
of flies		Faichnie 1929
in Musca domestica	exptl; 23 d; transmitted	Matheson 1950
Intestinal tract	5-23 d	
of flies		Fickler 1903
Intestinal tract	present	
of flies		Graham-Smith 1909
Intestinal tract	exptl; present	
of flies		Graham-Smith 1913
Externally	exptl; 11 d	
Intestinal tract	" 15 d	
Internally -		
killed with DDT	" 7 d	
" " fly paper	" 10 d	
of Musca domestica		Gross 1951
Intestinal tract	present	
of Musca domestica		Hamilton 1903
in Musca domestica	present	Howard 1911
In or on body	23 d	
of Musca domestica		Jordan 1908
in flies	present	Klein 1908
in Musca domestica	"	Ledingham 1911
in flies	"	Manson-Bahr 1919
in flies	"	Veeder 1898
S. paratyphi B		
in flies	exptl; 10 d	Faichnie 1909
Body	Inoc: fed a suspension of 12,000-48,000 org. Recov: multiplied in body	
Feces	present	
of Musca domestica		Hawley 1948
Feces	Inoc: 18,000-6,300,000 bacteria	
of Musca domestica	Recov: 1st d - 10-200,000,000; 6th d - 200,000,000	Hawley 1951
Intestines	at least 11 d	
of Musca domestica		Nicoll 1911

TABLE 9/16 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference	
FLIES (cont'd)			
S. paratyphi			
Intestinal tract of flies	multiplied		
Externally		Faichnie	1929
Intestinal tract of Musca domestica	exptl; present; 3 d	Gross	1951
Intestinal tract of Musca domestica	present	Torrey	1912
S. enteritidis			
Intestinal tract of Musca domestica	present	Bahr	1914
Externally of Musca domestica	present	Cox	1912
Intestinal tract of flies	present	Fickler	1903
Intestinal tract of flies	present	Graham-Smith	1909
Intestinal tract of flies	exptl; present	Graham-Smith	1913
Intestinal tract of Musca domestica	present	Hamilton	1903
Intestinal tract of Musca domestica	present	Ledingham	1911
in Musca domestica	duration of life of fly (approx. 4 wks)	Ostrolenk	1942
S. cholerae-suis			
in Musca domestica	present	Scott	1917
S. spp.			
Feces of Musca domestica	present	Hawley	1951
LICE			
S. typhosa			
in Pediculus capitis " corporis	present; transmitted	Abe	1907
S. enteritidis			
in lice	present	Huang	1937
MOSQUITOES			
S. paratyphi			
Intestines of Culex pipiens	3-4 wks.	Felsenfeld	1947
S. enteritidis			
in Aedes egypti	exptl; 1 hr.	Varela	1950
TICKS			
S. enteritidis			
Feces of Dermacentor andersoni	35 d	Parker	1943
in Dermacentor andersoni	present	Reitler	1946

TABLE 2/7 THE SURVIVAL OF SHIGELLA SPECIES IN INSECTS

Factor(s)	Survival	Reference
ANTS		
S. paradysenteriae		
Feet of ants	at least 24 hrs.	Griffitts 1942
FLIES		
S. dysenteriae		
Internal and external of Chrysomyia megacephala	5-6 d	Chow 1940
in flies	present	Dudgeon 1919
Body	Inoc: fed a suspension of 12,000-48,000 organisms Recov: multiplied in body	
Feces of Musca domestica	present	Hawley 1948
Feces of Musca domestica	Inoc: 12,000-6,300,000 bacteria Recov: 1st d - 10-200,000,000 6th d - 200,000,000	Hawley 1951
Bowel of flies	5 d	Manson-Bahr 1920
Feces of flies	11 d	Stewart 1944
S. paradysenteriae		
in flies	present	Graham-Smith 1909
in flies	"	Kuhns 1944
S. paradysenteriae (Flexner)		
in flies	273 hrs.	Stewart 1944
S. ambigua (S. dysenteriae-Schmitz)		
in flies	present; 297 hrs.	Stewart 1944
S. spp.		
Intestinal tract of flies	present	Fickler 1903
Intestinal tract of flies	present	Graham-Smith 1909
Intestinal tract of Musca domestica	present	Hamilton 1903
Intestinal tract of Musca domestica	present	Ledingham 1911
Intestinal tract of Musca domestica	present	Nicoll 1911

TABLE 2/8 THE SURVIVAL OF SPIROCHETES IN INSECTS

Factor(s)	Survival	Reference
FLIES		
Treponema pertenue		
in Hippelates pallipes	present; transmitted	Kumm 1936
in Musca domestica		
Hippelates pallipes		
" flavipes	present; transmitted	Steinhaus 1947
REDUVIIDS		
Leptospira icterohaemorrhagicae		
Intestinal tract of Triatoma infestans	exptl; present; 6 d	Liem 1941

TABLE 2/19 THE SURVIVAL OF VIBRIO SPECIES IN INSECTS

Factor(s)	Survival	Reference
COCKROACHES		
Vibrio comma		
Feces of Periplaneta americana	79 hrs.	Barber 1914
in Periplaneta americana	present	Toda 1923
FLIES		
Vibrio comma		
Feet, wings, body and feces of flies	present; transmitted	Alessandrini
in flies	present	Cattani 1886
in flies	exptl; present	Faichnie 1909
Intestinal tract	exptl; 48 hrs.	
Feces of Musca domestica	" 30 hrs.	Graham-Smith 1913
in Musca domestica	present	Hamilton 1903
in Musca domestica	present	Ledingham 1911
in flies	present	Macrae 1895
Feces of Eristalis tenax, Calliphora vomitoria	present	Maddox 1885
in Musca domestica	present	Nicoll 1911
in flies	present	Simmonds 1892

TABLE 920 THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
BEDBUGS			
Yellow fever virus			
in Cimex lectularis	2 d	Kumm	1932
Lymphocytic choriomeningitis virus			
22-25C	exptl; present; 10 min.		
in Cimex lecutlaris	to 85 d	Milzer	1942
COCKROACHES			
Poliomyelitis virus			
Intestinal tract	present; 24 hrs.		
of cockroaches		Hsiang	1952
Tissues - 30C	exptl; 15 d		
of cockroaches		Hurlbut	1949
Hemocoele	exptl; 15 d; transmitted		
of cockroaches		Hurlbut	1950
Poliomyelitis viruses - GDVII, C group A and human polio virus			
Body	exptl; present		
Feces	" killing amounts		
of Periplaneta americana	excreted for 7-15 d		
human polio virus			
in Periplaneta americana			
Supella supellactilium			
Blattella germanica	natural vectors for Brunhilde, Minnesota and Mahoney strains	Syverton	1952
Lymphocytic choriomeningitis virus			
in Blattella germanica	present	Steinhaus	1944
Coxsackie virus			
Feces	exptl; 15 d; transmitted		
of cockroaches		Fischer	1951
Mouse encephalitis virus			
Feces	exptl; present; trans-		
of cockroaches	mitted; 7 d	Syverton	1950
FLIES			
Poliomyelitis virus			
Lansing strain	exptl; 2 d		
Theiler strain	" 12 d		
	only when adult itself acquires virus by		
in Musca domestica	feeding	Bang	1943
Surface and alimentary tract	exptl; at least 48 hrs.		
of flies		Flexner	1911
Surface and alimentary tract	exptl; at least 48 hrs.		
of flies		Howard	1912
Tissues			
30C	exptl; 12 d		
of Musca domestica		Hurlbut	1949

TABLE 22d (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
FLIES (cont'd)			
Poliomyelitis virus (cont'd)			
Hemocoele of flies	exptl; 12 d; transmitted	Hurlbut	1950
in Phormia regina Phaenicia sericata Musca domestica Sarcophaga spp. Cynomyopsis cadaverina	present	Melnick	1949
Gut	exptl; 2 wks.		
Feces of Phormia regina	" 3 wks.	Melnick	1941
in Muscidae Calliphoridae	may harbor virus in nature	Paul	1941
Abdomen, feces, vomit (Lansing strain) of Musca domestica	exptl; 2 d	Rendtorff	1943
in Muscidae Calliphoridae	may harbor virus in nature	Sabin	1942
in Muscidae Calliphoridae	may harbor virus in nature	Toomey	1941
in Muscidae Calliphoridae	may harbor virus in nature	Trask	1943
LICE			
Eastern equine encephalitis virus			
in Eomenacanthus stramineus	present	Howitt	1948
MITES			
St. Louis encephalitis virus			
in Dermanyssus gallinae	exptl; present; transmitted	Smith	1941
in Dermanyssus gallinae	present; transmitted	Smith	1944
in Dermanyssus gallinae	" "	Smith	1945
Eastern equine encephalitis virus			
in Dermanyssus gallinae	present	Howitt	1948
Western equine encephalitis virus			
in Dermanyssus americanus	present	Miles	1951
in Liponyssus sylvarium	"	Reeves	1947
in Dermanyssus gallinae	"	Sulkin	1945
MOSQUITOES			
Yellow fever virus			
in Haemagogus capricorni	exptl; present; transmitted	Bates	1944
in " "	present; transmitted	Bushell	1944
in " "	" "	Bugher	1944
In Culex fatigans	exptl; 39 d; transmitted	Davis	1933

TABLE 9 2d (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
MOSQUITOES (cont'd)			
Yellow fever virus (cont'd)			
Most tissues of mosquitoes	Inoc: titer of 1 billion lethal doses/cc Recov: Immediately after - 1-2 million lethal doses 2 wks - 1% of inoc. exptl; 2 wks.	Davis	1933
in Aedes africanus	present; transmitted	Haddow	1948
in Aedes egypti	" "	Hargett	1944
in Aedes egypti	duration of life of mosquito (which may be over 200 d)	Herms	1950
in Aedes egypti	present; transmitted	Reed	1900
in mosquitoes 30C for 14 d, 1.1-4.4C thereafter	exptl; present; 32 d	Ross	1950
in Haemagogus capricorni	present; transmitted	Shannon	1938
in Aedes africanus	" "	Smithburn	1949
Nearly all tissues of approx. 20 spp.	through life of mosquito	Steinhaus	1947
in Aedes egypti			
killed with ether	4 hrs.		
" " tobacco smoke	20 hrs.		
" " KCN	45.5 hrs.		
" " Chloroform	½-1 hrs.		
starved	17.5 hrs.		
in Haemagogus equinus " spegazzinii	present	Waddell	1945
in Haemagogus capricorni	exptl; present	Waddell	1948
in " equinus	" "	Waddell	1947
in Aedes egypti	multiplied	Whitman	1937
Dengue fever virus			
in mosquitoes	present; transmitted	Ashburn	1907
Temp. below 18C	lose infectivity		
" above "	regain "		
in mosquitoes	174 d; transmitted	Blanc	1929
in Aedes egypti	present; transmitted	Chandler	1923
in mosquitoes	" "	Matheson	1950
in Aedes egypti	duration of life of mosquito (which may be over 200 d)	Herms	1950
in Aedes scutellaris	exptl; present; transmitted	Mackerras	1946
in Aedes egypti	present; virulence may lessen with serial passage; lives longer in live than dead tissues	Simmons	1931

TABLE 2.20 (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
MOSQUITOES (cont'd)			
St. Louis encephalitis virus			
in Culex tarsalis			
" pipiens			
" coronator			
" quinguefasciatus			
Aedes lateralis			
" taeniorhynchus			
" vexans			
" [illegible]			
Theobaldia incidens			
Culiseta inornata	exptl; present; transmitted	Hammon	1943
in Aedes dorsalis	present; transmitted	Hammon	1947
in Culex tarsalis	" "	Hammon	1943
in Culex pipiens			
" quinquefasciatus			
Anopheles punctipennis			
" quadrimaculatus			
Aedes egypti			
" triseriatus			
" vexans	exptl; present; transmitted	Smith	1941
in Culex tarsalis			
" pipiens			
Culiseta inornata	present; transmitted	Steinhaus	1947
Poliomyelitis virus			
in Culex pellens			
Aedes aloopictus	3 wks.	Paul	1947
Eastern equine encephalitis virus			
in Culiseta melanura	present; transmitted	Chamberlain	1951
in Aedes vexans			
" sollicitans			
" cantator			
" atropalpus			
" triseriatus	exptl; present	Matheson	1950
in Mansonia perturbans	present	Howitt	1949
in Aedes egypti	at least 36 d; transmitted	Kelser	1933
in Aedes egypti			
" sollicitans	1,000-10,000 fold increase; 63 d	Merrill	1934
All tissues of Aedes egypti	present for duration of life but able to transmit only approx. 2 mos.	Merrill	1935
in Aedes albopictus			
" sollicitans			
" dorsalis			
" lateralis			
" geniculatus			
" vexans	present; transmitted	Steinhaus	1947

TABLE 220 (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference
MOSQUITOES (cont'd)		
Western equine encephalitis virus		
in Aedes dorsalis		
Culex tarsalis	present; transmitted	Hammon 1947
in " "	" "	Hammon 1945
in " "	" "	Hammon 1943
in Aedes taeniorhynchus	" "	Kelser 1938
in Culex coronator		
Theobaldia incidens	exptl; present; transmitted	Steinhaus 1947
in Culex tarsalis		
" pipiens		
Culiseta inornata	present; transmitted	Steinhaus 1947
in Aedes dorslais	" "	Thompson 1951
Japanese B encephalitis virus		
in Culex tritaeniorhynchus		
" pipiens var. pallens	exptl; present; transmitted	Hammon 1949
in Culex tritaeniorhynchus	present	Hammon 1949
in Aedes chemnlpoensis	exptl; 15 d; transmitted.	
Culex pipiens var. pallens	exptl; 15 d; not transmitted.	Huang 1951
Temp. of 8-12C.	91 d	
in Culex quinquefasciatus		Hurlbut 1949
in mosquitoes	exptl; multiplied-max. titer recovered; 17d	Hurlbut 1951
in Culex quinquefasciatus		
" annulirostris	exptl; present	Hurlbut 1948
Lymphocytic choriomeningitis virus		
in Aedes egypti	exptl; present; transmitted	Coggeshall 1939
Temp. of 26-34 C.	exptl; present	
Temp. of 37C, 25C, or lower	exptl; not present	
in Culex pipiens		
" albopictus		Milzer 1942
Encephalomyocarditis virus (Mengo encephalomyelitis virus)		
in Taeniorhynchus fuscopennatus		
Taeniorhynchus spp.	present	Dick 1948
Venezuelan equine encephalitis virus		
in Aedes taeniorhynchus		
Anopheles neomaculipalpis		
Mansonia titillans	present; transmitted	Matheson 1950

TABLE 9.20 (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
MOSQUITOES (cont'd)			
Venezuelan equine encephalitis virus (cont'd)			
in Aedes geniculatus			
" aegypti			
" albopictus	exptl; present; transmitted	Roubaud	1941
Neurotropic virus group			
in Aedes spp.			
Psorophora spp.	present; transmitted	Laemmert	1947
in mosquitoes	present	Roca-Garcia	1944
Rift Valley fever virus			
in Eretmapodites spp.			
Aedes spp.	present; transmitted	Smithburn	1948
REDUVIIDS			
Yellow fever virus			
in Triatoma megista	exptl; 1 wk; not transmitted by bite	Davis	1933
Western equine encephalitis virus			
in Triatoma sanguisuga	present; transmitted	Kitselman	1940
Venezuelan equine encephalitis virus			
in Triatoma infestans	exptl; present; not transmitted; 17 d	Lepine	1941
TICKS			
Yellow fever virus			
in Amblyomma cajennense	15 d; not trans. by bite		
Argas persicus	6 d; " " " "		
Rhipicephalus sanguineus	23 d; " " " "		
Boophilus microphilus	10 d; " " " " exptl.	Davis	1933
Eastern equine encephalitis virus			
in Dermacentor andersoni	exptl; present; transmitted	Syverton	1941
Russian spring and summer encephalitis virus			
in Ixodes persulcatus	present; transmitted	Chumakov	1939
in " "	" "	Chumakov	1940
in Ornithodoros moubata	exptl; 40 d	Parker	1942
All organs	present		
gut	25 d		
of Ixodes persulcatus		Pavlovskii	1940
St. Louis encephalitis virus			
in Dermacentor variabilis	exptl; present; transmitted	Blattner	1941
Temp of 12.5C in Dermacentor variabilis	exptl; 10 mos.; transmitted	Blattner	1944

TABLE 22d (CONT'D) THE SURVIVAL OF VIRUSES IN INSECTS

Factor(s)	Survival	Reference	
TICKS (cont'd)			
<u>Colorado tick fever virus</u>			
in Dermacentor andersoni	present; transmitted	Florio	1948
in " variabilis	exptl; present; transmitted	Florio	1950
in " andersoni	present; transmitted	Florio	1950
<u>Lymphocytic choriomeningitis virus</u>			
in Dermacentor andersoni	present; transmitted	Humphreys	1944
Feces of Dermacentor andersoni	exptl; present; transmitted	Shaugnessy	1939

References (Insects)

1. Abe, N. 1907 Ueber den Nachweis von Typhusbacillen in Läusen Typhus Kranker. Münch, Med. Wochnschr., 54, 1924.
2. Adler, S., and Ashbel, R. 1942 The behavior of Spirochaeta persica in Pediculus humanus. Ann. Trop. Med. Parasitol., 36, 83 96.
3. Adler, S., and Ber, M 1941 The transmission of Leishmania tropica by the bite of Phlebotomus papatasii. Indian J. Med. Res., 29, 803 809.
4. Adler, S. and Theodor, O. 1929 Attempts to transmit Leishmania tropica by bite: the transmission of L. tropica by Phlebotomus sergenti. Ann. Trop. Med. Parasitol., 23, [illegible]
5. Adler, S. 1948 Cutaneus leishmaniasis, Pro. 4th Internat. Cong. Trop. Med. Malaria, Abt, Wash, D.C.
6. Alessandrini, G., and Sampietro, G. The vitality of cholera vibriones in milk and on the fly. Ann. Igiene Sper., 22, 623 650.
7. Alicata, J E. 1942 Experimental transmission of endemic typhus fever by the sticktight flea (Echidnophaga gallinacea). J. Wash. Acad. Sci. 32, 57 60.
8. André, C. 1908 (On flies and the dissemination of tubercle bacilli) (Quoted by Herms 1939, p. 298.)
9. Anigstein L , and Bader, M.N. 1943 Investigations on rickettsial diseases in Texas. I. Epidemiological role of ticks common to the Gulf Coast in relation to local spotted fever. Tex. Rep. [illegible] Med. [illegible] 105 115
10. Antonelli G [illegible] Igiene domestica. Gior. d. r. Soc. ital [illegible]
11. Arkwright, J.A. and Bacot, A.W. 192[illegible] Investigations of the etiology of typhus fever especially undertaken for the Egyptian Government in the Public Health Laboratories, Cairo Brit. J. Exptl. Path. [illegible] 70.
12. Ashburn, P.M. and C[illegible]g C F. 1907 Experimental investigations regarding the etiology of dengue fever. Philip. J. Sci., B. 2, 93 147.
13. Atkin, E.E. and Bacot, A. 1922 Experiments on the infectivity of typhus virus contained in lice (Pediculus humanus and Pedicinus longiceps). Brit. J Exptl. Path., 3, 196 203.
14. Bacot, A. 1911 On the persistence of bacilli in the gut of an insect during metamorphosis. Trans. Roy. Entomol. Soc. London Pt. II 497 500.
15. Bacot, A., and Martin, C.J. 1914 Observations on the mechanism of the transmission of plague by fleas. J. Hyg., Plague Suppl. III, 13 423 439.
16. Badger L.F 1932 Rocky Mountain spotted fever virus recovered from the dog tick Dermacentor variabilis found in nature. Pub. Health Rept., 47, 2365 2369.
17. Bahr, P.H. and Comb, H. 1914 A study of epidemic dysentery in Fiji Islands. Brit. Med. J., 1, 294 296.
18. Bang, F.B., and Glaser, R.W. 1943 The persistence of poliomyelitis virus in flies. Am. J. Hyg., 37, 320 324.
19. Barber, M.A. 1914 Cockroaches and ants as carriers of the vibrios of Asiatic cholera. Philip. J. Sci., Ser. B, 9, 1 4.
20. Bastianelli, G., Bignami, A.E., and Grassi, B. 1898 Coltivasione delle semilune maleriche dell' vomo nell' Anopheles claviger Fabr.: notapreliminare. Atti Re. Accad. Lincei, Rendic , 7, 313.

21. Bates, M. 1944 The Saimiri monkey as an experimental host for the virus of yellow fever. Am. J. Trop. Med., 24, 83-89.
22. Beck, C., and Coffee, W.B. 1943 Observations on Salmonella typhimurium. J. Bact., 45, 200.
23. Bertarelle, E. 1910 Verbreitung des Typhus durch the Fliegen. Zentr. Bakt. Parasitenk. Infekt., I Orig., 53, 486-495.
24. Bitter, R.S., and Williams, O.B. 1949 Enteric organisms from the American cockroach. J. Infectious Diseases, 85, 87-90.
25. Blanc, G., and Baltazard, M. 1941 Plague infection of Pulex irritans. Compt. rend. acad. sci., Paris, 213, 813-816.
26. Blanc, G.R., and Baltazard, M. 1941 Transmission du bacille de Whitmore par la puce du rat Xenopsylla cheopis. Compt. rend. acad. sci., Paris, 213, 541-543.
27. Blanc, G.R., and Baltazard, M. 1942 Transmission de L'infection à bacille de Whitmore par insectes piquers. I. Maladie experimentale du Cobaye. Ann. inst. Pasteur, 68, 281-293.
28. Blanc, G., and Bruneau, J. 1949 Natural infection of the bovine tick, Hyalomma mauritanicum with the rickettsia of Q fever. Bull. Acad. Nat. Med., 133, 115-117.
29. Blanc, G.R., and Caminopétros, J. 1929 Durée de conservation du virus de la dengue chez les Stegomyas. L'influence de la saison froide sur le bouroir infectant. Compt. rend acad. sci., Paris, 188, 1273-1275.
30. Blanc, G., Martin, L.A., and Maurice, A. 1946 Sur une Rickettsia isolee de Tiques dans le Sud marocain. Son identite probable avec R. burneti agent de la Q fever. Compt. rend. acad. sci., Paris, 223, 438-439.
31. Blanc, G.R., and Woodward, T.E. 1945 The infection of Pedicinus albidus Rudow, the maggot's louse, on typhus carrying monkeys (Macacus sylvanus). Am. J. Trop. Med., 25, 33-34.
32. Blattner, R.J., and Heys, F.M. 1941 Experimental transmission of St. Louis encephalitis to white Swiss mice by Dermacentor variabilis. Pro. Soc. Exptl. Biol. Med., 48, 707-710.
33. Blattner, R.J., and Heys, F.M. 1944 Blood sucking vectors of encephalitis: experimental transmission of St. Louis encephalitis (Hubbard strain) to white Swiss mice by the American dog tick, Dermacentor variabilis Say. J. Exptl. Med., 79, 439-454.
34. Boiron, H. 1949 Transmission par le pou de Spirochaeta duttoni var. crocidurae. Bull. Soc. Path. Exot., 42, 91-93.
35. Boiron, H., Koerber, R., and Carronnier, B. 1948 Apropos d'un cas de recurrente hispano-africaine importe a Dakar. Transmission de Spirochaeta hispanica par L'ornithodore et par le pou. Bull. Soc. Path. Exot., 41, 81-89.
36. Bollinger, O. 1874 Milzbrand. In Ziemssen's Handb. spec. Path. Therapie, 3, 457-482.
37. Borzenkov, A., and Donskov, G. 1933 The experimental infection of the tick Hyalomma volgense P. Schulze and E. Schlottke, 1929, with plague. Rev. Microbiol. Epidemiol. et Parasitol., 12, 30.
38. Boshell-Manrique, J., and Osorno-Mesa, E. 1944 Observations on the epidemiology of jungle yellow fever in Santander and Boyacá, Columbia. Sept., 1941, to April, 1942. Am. J. Hyg., 40, 170-181.
39. Bozhenko, V.P. 1935 The role of bedbugs (Cimex lectularis L.) in transmission and preservation of tularemia virus. Rev. Microbiol., 14, 436-440.

40. Bozhenko, V.P. 1936 On the role of the mosquitoes, Culex apicalis Ad., as carriers and transmitters of tularemia. Rev. Microbiol., 15, 445-449.
41. Brecher, G., and Wigglesworth, V.B. 1944 The transmission of Actinomyces rhodnii Erikson in Rhodnius prolixus Stal (Hemiptera) and its influence on the growth of the host. Parasitol., 35, 220-224.
42. Brigham, G.D. 1941 Two strains of endemic typhus fever virus isolated from naturally infected chicken fleas (Echidnophaga gallinacea). Public Health Repts., 56, 1803-1804.
43. Bruce, D., and Nabarro, D. 1903 Progress report on sleeping sickness in Uganda. Rept. Sleeping Sickness Comm. Roy. Soc., 1, 11-88.
44. Brumpt, E. 1912 La Trypanosoma cruzi evolue chez Conorhinus megistus, Cimex lectularis, Cimex boveti et Ornithodoros moubata, cycle evolutiv de ce parasite. Bull. Soc. Path. Exot., 5, 360.
45. Brumpt, E. 1932 Longevite du virus de la fievre boutonneuse (Rickettsia conorin sp.) chez la tique, Rhipicephalus sanguineus. Compt. rend. soc. biol., 110, 1199-1202.
46. Bugher, J.C., Boshell Manrique, J., Roca-Garcia, M., and Osorno-Mesa, E. 1944 Epidemiology of jungle yellow fever in Eastern Columbia. Am. J. Hyg., 39, 16-51.
47. Burroughs, A.L. 1947 Sylvatic plague studies. The vector efficiency of nine species of fleas compared with Xenopsylla cheopis. J. Hyg., 45, 371-396.
48. Burroughs, A.L., and Holdenried, R. 1944 Recovery of relapsing fever spirochaetes from Ornithodoros turicata (Duges) 1876, in California. J. Bact., 48, 609.
49. Bustamente, M.E., and Varela, G. 1946 Studies of Rocky Mountain spotted fever in Mexico. Rev. Inst. Salubridad y Enfermedades Trop., Mexico, 7, 75-78.
50. Bustamente, M.E., Varela, G., and Ortiz, M.C. 1946 Studies in Rocky Mountain spotted fever in Mexico. Rev. Inst. Salubridad y Enfermedades Trop., Mexico, 7, 39-48.
51. Bustamente, M.E., Varela, G., and Roch, E. 1947 Estudio de una nueva fiebre petequial aislada en Michoacán (Republic Mexicana) del Rhipicephalus sanguineus. Rev. Inst. Salubridad y Enfermedades Trop., Mexico, 8, 163-174.
52. Cabasso, V. 1947 Mass infection of body lice with Rickettsia prowazeki. Proc. Soc. Exptl. Biol. Med., 64, 439-440.
53. Cabrera, B.D., and Tubangui, M. 1951 Studies on filariasis in the Philippines. III. Aedes (Finlaya) poicilius (Theobald), The mosquito intermediate host of Wuchereria bancrofti in the Bicol region. Acta. Med. Philippina, 7, 221-229.
54. Callot, P., Vermeil, C., and Puech, J. 1950 Sur une souche de Q fever a Strasburg. Ann. Parasitol. Humaine et Compt., 25, 5-7.
55. Cao, G. 1898 Sul passagio dei microorganismi a traverso l'intestino di alcuni insetti. Ufficiale Sanit. Riv. Igiene Med. Patrica, 11, 337-348, 385-397.
56. Cao, G. 1906 Sul passagio dei germi a traverso le larve di alcuni insetti. Ann. Igiene Sper., 16, 645-664.
57. Carter, H.F. 1948 Records of filaria infections in mosquitoes in Ceylon. Ann. Trop. Med. Parasitol., 42, 312-321.
58. Caspari, E. 1939 Kann die Bettwanze bakterielle Infektionserreger verbeiten? Tib. Fakultesi Mecm. Istanbul., 1, 972-983.

59. Castaneda, M.R., and Zinsser, H. 1930 Studies on typhus fever. III. Studies of lice and bedbugs (Cimex lectularis) with Mexican typhus fever. J. Exptl. Med., 52, 661-668.
60. Castellani, A. 1903 Trypanosoma in sleeping sickness. Brit. Med. J., 1, 1218.
61. Cattani, G. 1886 Studj sul colera. Gazz Ospedali Milano, 7, 611.
62. Celli, A. 1888 Transmissibilita dei germi pathogeni mediante le dejectione delle mosche. Bull. Soc. Lancisiana Ospedali Roma, 1, 1.
63. Chagas, G. 1909 Über eine neue Trypanosomiasis des Menschens. Men. do Instit. Oswaldo Cruz, 1, 159-218.
64. Chamberlain, R.W., Robin, H., Kissling, R.E., and Edison, M.E. 1951 Recovery of virus of Eastern Equine Encephalomyelitis from a mosquito, Culiseta melanura. Proc. Soc. Exptl. Biol. Med., 77, 396-397.
65. Chandler, A.C., and Rice, L. 1923 Observations on the etiology of dengue fever. Am. J. Trop. Med., 3, 233-262.
66. Chang, K. 1943 Domestica flies as mechanical carriers of certain human intestinal parasites in Chengtu. J. West China Border Research Soc., 14, 92-98.
67. Chow, C.Y. 1940 The common blue-bottle fly, Chrysomyia megacephala, as a carrier of pathogenic bacteria in Peiping, China. Chinese Med. J., 57, 145-153.
68. Chumakov, M.P., and Gladkikh, S. 1939 On the role of Ixodidae in communicating spring and summer encephalitis. Bull. Biol. Med. Exptl., U.R.S.S., 7, 221-223.
69. Chumakov, M.P., and Seitlenok, N.A. 1940 Tick-borne human encephalitis in the European part of USSR and Siberia. Science, 92, 263-264.
70. Chung, H., and Feng, L.C. 1936 Studies on the development of Spirochaeta recurrentis in body louse. China Med. J., 50, 1181-1184.
71. Cochrane, E.W.W. 1912 A small epidemic of typhoid fever in connection with specifically infected flies. J. Roy. Army Med. Corps, 18, 271-276.
72. Coggeshall, L.T. 1939 The transmission of lymphocytic choriomeningitis by mosquitoes. Science, 89, 515-516.
73. Cox, H.R. 1940 Rickettsia diaporica and American Q fever. Am. J. Trop. Med., 20, 463-469.
74. Cox, G.L., Lewis, F.C., and Glynn, E.E. 1912 The numbers and varieties of bacteria carried by the common house-fly in sanitary and insanitary city areas. J. Hyg., 12, 230-319.
75. Currie, D.G. 1910 Mosquitoes in relation to the transmission of leprosy. Flies in relation to the transmission of leprosy. Public Health Repts., 39, 42 pp.
76. DaRocha-Lima, H. 1916 Zur Aetiologie des Fleckfiebers. Berliner Klin. Wochnschr., 53, 567-569.
77. Davis, G.E. 1935 Tularemia susceptibility of the white-tailed prairie dog, Cynomys leucurus Merriam. Public Health Repts., 50, 731-732.
78. Davis, G.E. 1939 Rickettsia diaporica: recovery of three strains from Dermacentor andersoni collected in southeastern Wyoming; their identity with Montana strain I. Public Health Repts., 54, 2219-2227.

79. Davis, G.E. 1940 Bacterium tularense: its persistence in the tussues of the argasid ticks Ornithodoros turicata and O. parkeri. Public Health Repts., 55, 676-680.
80. Davis, G.E. 1943 American Q fever: experimental transmission by the argasid ticks Ornithodoros moubata and O. hermsi. Public Health Repts., 58, 839-842.
81. Davis, G.E. 1943 Further attempts to transmit Pasteurella tularensis by the bedbug (Cimex lectularis). J. Parasitol., 29, 395-396.
82. Davis, G.E., and Kohls, G.M. 1937 Ixodes ricinus californicus (Banks) as a possible vector of Bacterium tularense. Public Health Repts., 52, 281-282.
83. Davis, N.C. 1933 Transmission of yellow fever virus by Culex fatigans Wiedemann. Ann. Entomol. Soc. Am., 26, 491-494.
84. Davis, N.C. 1933 Attempts to transmit yellow fever virus with Triatoma megista. J. Parasitol., 19, 209-214.
85. Davis, N.C. 1933 The survival of yellow fever virus in ticks. Am. J. Trop. Med., 13, 547-554.
86. Davis, N.C., Frobisher, M., Jr., and Lloyd, W. 1933 The titration of yellow fever virus in stegomyia mosquitoes. J. Exptl. Med., 58, 211-226.
87. Delpy, L., and Kaweh, M. 1937 Transmission de Bacillus anthracis a l'homme par Argas persicus Oken 1818. Rev. Path. Comparee, 37, 1229-1234.
88. Dennis, E.W. 1931 The life history of Babesia bigemina in the North American fever tick. Science, 73, 620-621.
89. Dennis, E.W. 1932 The life cycle of Babesia begemina (Smith and Kilbourne) of Texas cattle fever in the tick Margaropus annulatus (Say). Univ. Calif. Pub. Zool., 36, 263-298.
90. Dewèvre, L. 1892 Note sur le role des pediculi dans la propagation de l'impetigo. Compt. rend. soc. biol., 4, 232-234.
91. Dick, G.W.A., and Lewis, E.A. 1947 A rickettsial disease in East Africa transmitted by ticks (Rhipicephalus sinus and Haemaphysalis leachi). Trans. Roy. Soc. Trop. Med. Hyg., 41, 295-326.
92. Dick, G.W.A., Smithburn, K.C., and Haddow, A.J. 1948 Mengo encephalomyelitis virus: Isolation and immunological properties. Brit. J. Exptl. Path., 29, 187.
93. Douglas, J.R., and Wheeler, C.M. 1943 Sylvatic plague studies. II. The fate of Pasteurella pestis in the flea. J. Infectious Diseases, 72, 18-30.
94. Dove, W.E., and Shelmire, B. 1931 Tropical rat mites, Liponyssus bacoti Hirst, vectors of endemic typhus. J. Am. Med. Assoc., 97, 1506-1510.
95. Dudgeon, L.S. 1919 The dysenteries: bacillary and amoebic. Brit. Med. J., 1, 448-451.
96. Duncan, J.T. 1926 On a bactericidal principle present in the alimentary canal of insects and arachnids. Parasitol., 18, 238-252.
97. Dutton, J.E., and Todd, J.L. 1905 The nature of human tick fever in the eastern part of the Congo Free State with notes on the distribution and bionomics of the tick. Liverpool School Trop. Med., Mem. XVIII.
98. Dyer, R.E. 1934 Effect of flea passage on epidemic typhus virus. Public Health Repts., 49, 224-225.
99. Dyer, R.E., Badger, L.F., and Rumreich, A. 1931 Rocky Mountain spotted fever (eastern type) transmission by the American dog tick (Dermacentor variabilis). Public Health Repts., 46, 1403-1413.

100. Dyer, R.E., Cedar, E.T., Workman, W.G., Rumreich, A., and Badger, L.F. 1932 Transmission of endemic typhus by rubbing either crushed infected fleas or infected flea feces into wounds. Public Health Repts., 47, 131-133.
101. Dyer, R.E., Rumreich, A., and Badger, L.F. 1931 Typhus fever. A virus of the typhus type derived from fleas collected from wild rats. Public Health Repts., 46, 334-338.
102. Elkins, J.C. 1951 Chaga's disease and vectors in North Central Texas. Field and Lab., 19, 95-99.
103. Eskey, C.R. 1938 Fleas as vectors of plague. Am. J. Public Health, 28, 1305-1310.
104. Eskey, C.R., and Haas, V.H. 1939 Infection in rodents, experimental transmission by fleas, and inoculation tests for infection. Public Health Bull., Wash., No. 32, 1467.
105. Eskey, C.R., Prince, F.M., and Fuller, F.B. 1949 Transmission of Salmonella enteritidis by the rat fleas Xenopsylla cheopis and Nosopsyllus fasciatus. Public Health Repts., 64, 933-941.
106. Ewing, H.E., Jr. 1942 The relation of flies (Musca domestica L.) to the transmission of bovine mastitis. Am. J. Vet. Research, 3, 295-299.
107. Eyles, D.E., and Most, H. 1947 Infectivity of Pacific Island Wuchereria bancrofti to mosquitoes of the United States. Am. J. Trop. Med., 27, 212-219.
108. Eyles, D.E., Young, M.D., and Burgess, R.W. 1948 Infectivity to Anopheles quadrimaculatus of asymptomatic Plasmodium vivax parasitemias. J. Natl. Malaria Soc., 7, 125-133.
109. Eyles, D.E., and Jeffery, G.M. 1949 The experimental transmission of Plasmodium falciparum by Anopheles albimanus. J. Natl. Malaria Soc., 8, 344-345.
110. Faddeeva, T. 1932 The role of ticks in the transmission and preservation of plague virus. Rev. Microbiol. Epidemiol. Parasitol., 12, 279.
111. Faichnie, N. 1909 Fly-borne enteric fever; the source of infection. J. Roy. Army Med. Corps, 13, 580-584.
112. Faichnie, N. 1909 Bacillus typhus in flies. J. Roy. Army Med. Corps, 13, 672.
113. Faichnie, N. 1929 The etiology of enteric fever: Personal views and experiences. J. Med. Assoc. S. Africa, 3, 669-675.
114. Felsenfeld, O., Young, V.M., and Conner, P. 1947 Progress in the knowledge of gram negative enteric pathogenic organisms during the year from 1938-1945. Pontifica Academia Scientiarum, 16, 1-75.
115. Feng, L.C., and Lu, W.C. 1949 The survival of Leishmania donovani in Ornithodoros moubata. Peking Nat. Hist. Bull., 17, 241-243.
116. Fickler, M. 1903 Typhus und Fliegen. Arch. Hyg., 46, 274-283.
117. Firth, R.H. (Maj.), and Horrocks, W.H. (Maj.) 1902 An inquiry into the influence of soil, fabrics, and flies in the dissimination of enteric infection. Brit. Med. J., 2, 936-943.
118. Fischer, R.G., and Syverton, J.T. 1951 The cockroach as an experimental vector of Coxsackie virus. Am. J. Trop. Med., 31, 238-241.

119. Flexner, S., and Clark, P.F. 1911 Contamination of the fly with poliomyelitis virus. J. Am. Med. Assoc., 56, 1717-1718.
120. Floch, H., and Delajudie, P. 1947 Recherches sur la trypanosomiase humaine americaine en Guyane francaise. Rhodnius prolixus et Rhodnius pictipes vecteurs naturels de choix de S. cruzi. Bull. Soc. Path. Exot., 40, 157-160.
121. Florio, L., and Miller, M.S. 1948 The epidemiology of Colorado tick fever. Am.J. Public Health, 38, 211-213.
122. Florio, L., Miller, M., and Mugrage, E.R. 1950 Colorado tick fever; Isolation of the virus from Dermacentor variabilis obtained from Long Island, New York, with immunological comparisons between eastern and western strains. J. Immunol., 64, 265-273.
123. Florio, L., Miller, M., and Mugrage, E.R. 1950 Colorado tick fever: Isolation of the virus from Dermacentor andersoni in nature and a laboratory study of the transmission of the virus in the tick. J. Immunol., 64, 251-263.
124. Francis, E. 1927 Microscopic changes of tularemia in the tick Dermacentor andersoni and the bedbug Cimex lectularis. Public Health Repts., 42, 2763-2772.
125. Francis, E. 1938 Longevity of the Ornithodoros turicata and of Spirochaeta recurrentis within this tick. Public Health Repts., 53, 2220-2241.
126. Francis, E., and Lake, G.C. 1921 Experimental transmission of tularemia in rabbits by the rabbit louse Haemodipus ventricosus. Public Health Repts., 36, 1747-1753.
127. Francis, E., and Lake, G.C. 1922 Transmission of tularemia by the bedbug Cimex lectularis. Public Health Repts., 37 83-95.
128. Francis, E., and Lake, G.C. 1922 Transmission of tularemia by the mouse louse Polyplax serratus. Public Health Repts., 37, 96-101.
129. Francis, E., and Mayne, B. 1921 Experimental transmission of tularemia by blies of the species Chrysops discalis. Public Health Repts., 36, 1738-1746.
130. Frye, W.W., and Meleney, H.E. 1932 Investigations of Endamoeba histolytica and other intestinal protozoa in Tennessee. A study of flies, rats, mice and some domestic animals as possible carriers of protozoa of man in a rural community. Am. J. Hyg., 16, 729-748.
131. Frye, W.W., and Meleney, H.E. 1936 The viability of Endamoeba, histolytica cysts after passage through the cockroach. J. Parasitol., 22, 221-222.
132. Galli-Valerio, B. 1907 Les insects comme propagateurs des maladies: Le role des arthropodes dans la dissemination des maladie. Ber. XIV Intern. Kongr. Hyg. Demogr., Berlin, 189-194.
133. Gambles, R.M., and Coghill, N.F. 1948 Relapsing fever in Cyrus. Ann. Trop. Med. Parasitol., 42, 288-303.
134. Gill, C.A. 1938 The seasonal periodicity of malaria. London
135. Grioud, P., and Jadin, J. 1950 Attempts at isolation of Q fever rickettsiae in Ruanda-Urundi from cow's milk, goat brains and ticks. Bull. Soc. Path. Exot., 43, 672-673.
136. Gispen, R. 1950 The virus of murine typhus in mites (Schöngastia indica, Fam. Trombiculidae). Drumenta Neerland et Indonesica Morbis Trop., 2, 225-230.

137. Graham-Smith, G.S. 1909 Preliminary note on examinations of flies for the presence of colon bacilli. Gt. Brit. Local Govt. Bd., Repts. Pub. Health Med. Subjs., N.S., 16, 9-13.
138. Graham-Smith, G.S. 1910 Observations on the way in which artificially infected flies (Musca domestica and Calliphora erythrocephala) carry and distribute pathogenic and other bacteria. Gt. Brit. Local Govt. Bd., Repts. Pub. Health Med. Subjs., 40, 1-40.
139. Graham-Smith, G.S. 1913 Flies in relation to disease. Cambridge Univ. Press, London. 292 pp.
140. Green, R.G. 1931 The occurrence of Bacterium tularense in the eastern wood tick, Dermacentor variabilis. Am. J. Hyg., 14, 600-613.
141. Green, R.G., and Evans, C.A. 1938 Role of fleas in the natural transmission of tularemia. Minn. Wildlife Dis., Invest., April, 1938, pp. 25-28.
142. Griffitts, S.D. 1942 Ants as probable agents in the spread of Shigella infections. Science, 96, 271-272.
143. Gross, H., and Preuss, U. 1951 Experimental infections of flies with enteric pathogens. Experiments with Salmonella typhi and S. paratyphi A and B. Zentr. Bakt. Parasitenk. (Abt. I) Orig. 156, 371-377.
144. Haddow, A.J., Smithburn, K.C., Dick, G.W.A., Kitchen, S.F., and Lumsden, W.H.R. 1948 Implication of the mosquito Aedes (Stegomyia) africanus Theobald in the forest cycle of yellow fever in Uganda. Ann. Trop. Med. Parasitol., 42, 218-223.
145. Hamilton, A. 1903 The fly as a carrier of typhoid; an inquiry into the part played by the common house-fly in the recent epidemic of typhoid fever in Chicago. J. Am. Med. Assoc., 40, 576-583.
146. Hammon, W.McD., and Reeves, W.C. 1943 Laboratory transmission of St. Louis encephalitis virus by three genera of mosquitoes. J. Exptl. Med., 78, 241-253.
147. Hammon, W.McD., and Reeves, W.C. 1947 Interepidemic studies on arthropod-borne virus encephalitides and poliomyelitis in Kern County, California, and the Yakima Valley, Washington, 1944. Am. J. Hyg., 46, 326-335.
148. Hammon, W.McD., Rees, D.M., Casals, J., and Meiklejohn, G. 1949 Experimental transmission of Japanese B encephalitis virus by Culex tritaeniorhynchus and Culex pipiens var. pallens, suspected natural vectors. Am. J. Hyg., 50, 46-50.
149. Hammon, W.McD., Reeves, W.C., and Galindo, P. 1945 Epizoology of Western Equine type encephalomyelitis: eastern Nebraska field survey of 1943 with isolation of the virus from mosquitoes. Am. J. Vet. Research, 6, 145-148.
150. Hammon, W.McD., Reeves, W.C., and Gray, M. 1943 Mosquito vectors and inapparent animal reservoirs of St. Louis and western equine encephalitis viruses. Am. J. Public Health, 33, 201-207.
151. Hammon, W.McD., Tigertt, W.D., Sather, G., and Schenker, H. 1949 Isolations of Japanese B encephalitis virus from naturally infected Culex tritaeniorhynchus collected in Japan. Am. J. Hyg., 50, 78.
152. Hargett, M.V. 1944 The control of yellow fever. Seen in manuscript by Steinhaus.

153. Harris, A.H., and Down, H.A. 1946 Studies on the dissemination of cysts and ova of juman intestinal parasites by flies in various localities on Guam. Am. J. Trop. Med., 26, 789-900.
154. Hass, G.M., and Pinkerton, H. 1936 Spotted fever. III. An experimental study of "Fievre Boutonneuse". J. Exptl. Med., 64, 601-623.
155. Hawley, J.E. 1948 A study on the multiplication of some enteric bacteria in Musca domestica. Master's Thesis, Univ. Conn., Storrs, Conn.
156. Hawley, J.E., Penner, L.R., Wedberg, S.E., and Kulp, W.L. 1951 The role of the house fly, Musca domestica, in the multiplication of certain enteric bacteria. Am. J. Trop. Med., 31, 572-582.
157. Heisch, R.B. 1949 The human louse in transmission of Trypanosoma duttoni in nature. Brit. Med. J., 17, 4591.
158. Herms, W.B. 1939 Medical entomology. 3d ed. The Macmillan Co., New York. 582pp.
159. Herms, W.B. 1950 Medical entomology. 4th ed. The Macmillan Co., New York. 643pp.
160. Hindle, E. 1921 Notes on rickettsia. Parasitol., 13, 152-159.
161. Hindle, E., and Duncan, J.T. 1925 The viability of bacteria in Argas persicus. Parasitol., 17, 434-446.
162. Hofmann, E. 1888 Ueber die Verbreitung der Tuberculose durch Stubenfliegen. Correspondenzbl d. arztl. Kreis u. Bezirksuereine Konigr. Sachsen, 44, 130-133.
163. Honeij, J.A., and Parker, R.R. 1914 Leprosy: flies in relation to the transmission of the disease. J. Med. Research, 30, 127-130.
164. Hopla, C.E. 1951 Experimental transmission of tularemia by the tropical rat mite. Am. J. Trop. Med., 31, 768-782.
165. Howard, C.W., and Clark, P.F. 1912 Experiments on insect transmission of the virus of poliomyelitis. J. Exptl. Med., 16, 850-859.
166. Howard, L.O. 1911 The house fly; disease carrier. 2d ed. Frederick A. Stokes Co., New York. 312pp.
167. Howitt, B.F., Dodge, H.R., Bishop, L.K., and Gorrie, R.H. 1948 Virus of eastern equine encephalitis isolated from chicken mites (Dermanyssus gallinae) and chicken lice (Ecomenacanthus stramineus). Proc. Soc. Exptl. Biol. Med., 68, 622-625.
168. Howitt, B.F., Dodge, H.R., Bishop, L.K., and Gorrie, R.H. 1949 Recovery of the virus of eastern equine encephalitis from mosquitoes (Mansonia perturbans) collected in Georgia. Science, 110, 141-142.
169. Hsiang, C.M., Pollard, M., and Micks, D.W. 1952 The possible role of the cockroach in dissemination of poliomyelitis virus. Tex. Repts. Biol. Med., 10, 329-335.
170. Huang, C.H., Chang, H.C., and Lien, V.T. 1937 Salmonella infection. A study of 17 cases of S. enteritidis septicemia..
171. Huang, C.H., Feng, L.C., and Jen, K.H. 1951 Experimental transmission of the Peking strain of Japanese B encephalitis virus by Aedes chemulpoensis and Culex pipiens var. pallens. Peking Nat. Hist. Bull., 19, 144.
172. Huebner, R.J., Jellison, W.L., and Pomerantz, C. 1946 Rickettsialpox - a newly recognized rickettsial disease. IV. Isolation of a rickettsia apparently identical with the causative agent of rickettsialpox from Allodermanyssus sanguineus a rodent mite. Public Health Repts., 61, 1677-1682.

173. Humphreys, F.A., Helmer, D.E., and Gibbons, R.J. 1944 Studies on a virus disease orginating in guinea pigs injected with ticks (Dermacentor andersoni). J. Infectious Diseases, 74, 109-120.
174. Hurlbut, H.S. 1949 The recovery of poliomyelitis virus after parenteral introduction into cockroaches and houseflies. Naval Med. Res. Inst., Bethesda, Md., Report No. 8.
175. Hurlbut, H.S. 1949 The transmission of Japanese encephalitis by mosquitoes after experimental hibernation. Naval Med. Res. Inst., Bethesda, Md., Report No. 9.
176. Hurlbut, H.S. 1951 The propagation of Japanese encephalitis virus in the mosquito by parenteral introduction and serial passage. Am. J. Trop. Med., 31, 254.
177. Hurlbut, H.S. 1950 The recovery of poliomyelitis virus after parenteral introduction into cockroaches and houseflies. J. Infectious Diseases. 86, 103-104.
178. Hurlbut, H.S. 1948 Potential vectors of Japanese encephalitis in the Caroline Islands. Naval Med. Res. Inst., Bethesda, Md., Report No. 5.
179. Irons, J.V., Bohls, S.W., Thruman, D.C., and McGregor, T. 1944 Probable role of the cat flea, Ctenocephalides felis, in transmission of murine typhus. Am. J. Trop. Med., 24, 259-362.
180. Jadin, J., and Giroud, P. 1950 Q fever at Ruanda-Urundi. 1950 Bull. Soc. Path. Exot., 43, 667-672.
181. James, S.P. 1927 History of a group of Anopheles mosquitoes infected with Plasmodium vivax. Abh. Gebiete Auslandsk., Hamburg Univ., Ser. D, 26, 220-222.
182. Janssen, W.A., Wedberg, S.E. 1952 The common house-roach, Blattella germanica Linn., as a potential vector of Salmonella typhimurium and Salmonella typhosa. Am. J. Trop. Med. Hyg., 1, 337-343.
183. Jeffery, G.M., Eyles, D.E, and Young, M.D. 1950 The comparative susceptibility of Anopheles quadrimaculatus and two strains of Anopheles albiminus to a Panama strain of Plasmodium falciparum. J. Natl. Malaria Soc., 9, 349-355.
184. Jellison, W.L., Bell, E.J., Huebner, R.J., Parker, R.R., and Welsh, H.H. 1948 Q fever studies in southern California. IV. Occurrence of Coxiella burneti in the spinose ear tick, Otobius megnini. Public Health Repts., 63, 1483-1489
185. Joly, P.R. 1898 Importancia de papal de los insectos en la transmission de las enfermgdades infeciosas y parasitarias. Tr. L. Gaitan, Bol. Consejo. Sup. Solubridad., 329-337.
186. Jordan, E.O. 1908 A textbook of general bacteriology. 13th Ed. W.B. Saunders Co., Philadelphia. 731pp.
187. Kamil, S., and Bilal, S. 1938 Recherches experimentales sur l'etiologie de la tularemia en Turquie. Ann. Parasitol. Humaine et Comparée, 16, 530-542.
188. Kawamura, R., and Imagawa, Y. 1931 Ueber dei Proliferation der pathogenen Rickettsia in tierischen Organismus bei der Tsutsugamuchi-Krankheit. Trans. Japan. Path. Soc., 21, 455-461.
189. Kelser, R.A. 1933 Mosquitoes as vectors of the virus of equine encephalomyelitis. J. Am. Vet. Med. Assoc., 82, 767-771.
190. Kelser, R.A. 1938 Transmission of the virus of equine encephalitis by Aedes taeniorhynchus. J. Am. Vet. Med. Assoc., 102, 195-203.

191. King, W.V. 1917 The effect of cold upon malaria parasites in the mosquito host. J. Exptl. Med., 25, 495-498.

192. Kinghorn, A., and Yorke, W. 1912 On the transmission of human trypanosomes in Glossina morsitans Westw.; and on the occurrence of human trypanosomes in game. Ann. Trop. Med. Parasitol., 6, 1-23, 269-285.

193. Kitashima, T., and Miyajima, R.M. 1918 Studien uber die Tsutsugamushi Krankheit. Kitasato Arch. Exptl. Med., 2, 91-146, 237-334.

194. Kitselman, C.M., and Grundmann, A.W. 1940 Equine encephalitis virus isolated from naturally infected Triatoma sanguisuga LeConte. Kansas Agr. Exptl. Sta. Bull., 50. 15pp.

195. Klein, E. 1908 "Flies" as carriers of the Bacillus typhosus. Brit. Med. J., 2, 1150-1151.

196. Kleine, F.K. 1909 Positive Infektionsversuche mit Trypanosoma brucei durch Glossina palpalis. Deut. med. Wochschr., 35, 469.

197. Kodama, M., and Kono, M. 1933 Studies on experimental transmission of virus of "eruptive fever" and "typhus" by several blood sucking insects. Kitasato Arch. Exptl. Med., 10, 99-112.

198. Kofoid, C.A., and Donat, F. 1933 South American trypanosomiasis of the human type-occurrence in mammals in the United States. Calif. West. Med., 38, 245-249.

199. Kohls, G.M., Armbrust, C.A., Irons, E.N., and Philip, C.B. 1945 Studies on tsutsugamushi disease (Scrub typhus, mite borne typhus) in New Guinea and adjacent islands: Further observations on epidemiology and etiology. Am. J. Hyg., 41, 374-396.

200. Krishnan, K.V., Smith, R.O.A., Bose, P.N., Neogy, K.N., Roy, B.K.G., and Ghosh, M. 1949 Transmission of Rickettsia orientalis by the bite of the larvae of Trombicula deliensis. Indian Med. Gaz., 84, 41-43.

201. Krishnan, K.V., Smith, R.O.A., Bose, P.N., Neogy, K.N., Ghosh, Roy, B.K., and Ghosh, M. 1949 Epidemiological observations on XK or mite-borne typhus in Barrackpore, Bengal. Indian Med. Gaz., 84, 63-68.

202. Kuhns, D.M., and Anderson, T.G. 1944 A fly-borne bacillary dysentery epidemic in a large military organization. Am. J. Public Health, 34, 750-755.

203. Kumm, H.W., and Frobisher, M., Jr. 1932 Attempts to transmit yellow fever with certain Brazilian mosquitoes (Culicidae) and with bedbugs (Cimex hemipterus). Am. H. Trop. Med., 12, 349-361.

204. Kumm, H.W., and Turner, T.B. 1936 The transmission of yaws from man to rabbits by an insect vector, Hippelates pallipes Loew. Am. J. Trop. Med., 16, 245-271.

205. Kuster, H.A. 1902 Uber den Durchgang von Bakterien durch Insektendarm. Inaugural Dissertation, Univ. Heidelberg, Rossler. 44pp.

206. Lackman, D.B., Parker, R.R., and Gerloff, R.K. 1949 Serological characteristics of a pathogenic rickettsia occurring in Amblyomma maculatum. Public Health Repts., 64, 1342-1349.

207. Laemmert, H.W., Jr., and Hughes, T.P. 1947 The virus of Ilheus encephalitis. Isolation, serological specificity and transmission. J. Immunol. Virus-Res. Exptl. Chemotherapy. 55, 61-67.

208. Ledingham, J.C.G. 1911 On the survival of specific microorganisms in pupae and imagines of Musca domestica raised from experimentally infected larvae. Experiments with B. typhosus. J. Hyg., 11, 333-340.
209. Lepine, P., Mathis, M., and Sauter, V. 1941 Infestation experimentale de Triatoma infestans par le virus de l'encephalomyelite equine americaine, type Venezuola. Bull. Soc. Path. Exot., 34, 115.
210. Liem, S.D. 1941 The behavior of Spirochaeta duttoni and Leptospira icterohaemorrhagiae in Triatoma infestans (Klug). Acta Leiden. Scholae Med. Trop., 15/16, 248.
211. Lien teh, W., Chun, J.W., Pollitzer, R., and Wu, C.Y. 1936 Plague. A manual for medical and public health workers. The Mercury Press, Shanghai. 547pp.
212. Liston, W.G. 1905 Plague, rats and fleas. J. Bombay Nat. Hist. Soc., 16, 253-274.
213. Liu, W.T. 1944 Sutdies on the murine origin of typhus epidemics in North China. 3. Isolation of murine typhus rickettsia from rats, rat fleas and body lice of patients during an epidemic in a poor house. Chinese Med. J., 62, 119-139.
214. Liu, W.T. 1947 Isolation of typhus rickettsiae from rat mites, Liponyssus bacoti in Peiping. Am. J. Hyg., 45, 58-66.
215. Long, E.C. 1911 Note on the transmission of leprosy. J. Trop. Med. Hyg., 14, 254.
216. Longfellow, R.C. 1913 The common house roach as a carrier of disease. Am. J. Public Health, 3, 58-61.
217. Macfie, J.W.S. 1922 Observations on the role of cockroaches in disease. Ann. Trop. Med., 16, 441-448.
218. Mackerras, I.M. 1946 Transmission of dengue fever by Aedes (Stegomyia) scutellaris Walk. in New Guinea. Trans. Roy. Soc. Trop. Med. Hyg., 40, 295-312.
219. Mackerras, M.J., and Mackerras, I.M. 1948 Salmonella infections in Australian cockroaches. Australian J. Sci., 10, 115.
220. Mackerras, I.M., and Pope, P. 1948 Experimental salmonella infections in Australian cockroaches. Australian J. Exptl. Biol. Med. Sci., 26, 465-470.
221. Mackie, F.P. 1907 The part played by Pediculus corporis in the transmission of relapsing fever. Brit. Med. J., 2, 1706-1709.
222. Mackie, T.T., Davis, G.E., Fuller, H.S., Knapp, J.A., Steinacker, M.L., Stager, K.E., Traub, R., Jellison, W.L., Millspaugh, D.D., Austrian, R.C., Bell, E.J., Kohls, G.M., Wei Hsi, and Girsham, J.A.V. 1946 Observations on tsutsugamushi disease (Scrub typhus) in Assam and Burma. Am. J. Hyg., 43, 195-218.
223. Macrae, R. 1895 Flies and cholera diffusion. Indian Med. Gaz., 29, 407-412.
224. Maddox, R.L. 1885 Experiments on feeding some insects with the curved or "comma" bacillus, and also with another bacillus (subtilis?). J. Roy. Microsop. Soc., Ser. 2, pt. II, 5, 602-607, 941-952.
225. Manson, P. 1898 Surgeon-Major Ronald Ross's recent investigations on mosquito malaria theory. Brit. Med. J., 1, 1575-1577.

226. Manson-Bahr, P. 1919 Bacillary dysentery. Trans. Roy. Soc. Trop. Med. Hyg., 13, 64-72.
227. Manson-Bahr, P. 1920 Quoted by Major W. Stewart, 1944.
228. Mariani, G. 1940 Classification of human pathogenic rickettsia isolated in the Ethiopian tableland. Pathologica, 32, 393-402.
229. Mariotte, C.O., Bustamente, M.E., and Varela, G. 1944 Specimens of *Rhipicephalus sanguineus* found naturally infected with Rocky Mountain spotted fever in Sonora (Mexico). Rev. Inst. Salubridad y Enfermedades Trop. Mexico, 5, 297-300.
230. Martinaglia, G. 1932 The fate of anthrax bacilli in ticks from an anthrax carcass. J. Am. Vet. Med. Assoc., 80, 805-806.
231. Matheson, R. 1950 Medical entomology. 2d ed. Comstock Publishing Co., Ithaca, New York. 612pp.
232. Matheson, R., Boyd, M.F., and Stratman-Thomas, W.K. 1933 *Anopheles walkeri*, Theobald, as a vector of *Plasmodium vivax*, Grassi and Feletti. Am. J. Hyg., 17, 515-516.
233. Mayne, B. 1922 How long does a mosquito retain malaria parasites? Public Health Repts., 37, 1059-1063.
234. Mazzotti, L., and Varela, G. 1946 Experimental maintenance of Rocky Mountain spotted fever virus in *Ornithodoros furcosus*. Rev. Inst. Salubridad y Enfermedades Trop. Mexico. 7, 13-15.
235. McCoy, G.W. 1911 A plague-like disease of rodents. Public Health Bull., 43, 53-71.
236. McCoy, G.W., and Clegg, M.T. A note on acid-fact bacilli in head lice, (*Pediculus capitis*). Public Health Repts., 27, 1464-1465.
237. MacGregor, M.E. 1917 A summary of our knowledge of insect vectors of disease. Bull. Entomol. Research, 8, 155-163.
238. Melnick, J.L. 1949 Isolation of poliomyelitis virus from single species of flies collected during an urban epidemic. Am. J. Hyg., 49, 8-16.
239. Melnick, J.L., and Penner, L.R. 1947 Experimental infection of flies with human poliomyelitis virus. Proc. Soc. Exptl. Biol. Med., 65, 342-346.
240. Merrill, M.H., Lacaillade, C.W., Jr., and Ten Broeck, C. 1934 Mosquito transmission of equine encephalomyelitis. Science, 80, 251-252.
241. Merrill, M.H., and Ten Broeck, C. 1934 Multiplication of equine encephalomyelitis virus in mosquitoes. Proc. Soc. Exptl. Biol. Med., 32, 421-423.
242. Merrill, M.H., and Ten Broeck, C. 1935 The transmission of equine encephalomyelitis by *Aedes aegypti*. J. Exptl. Med., 62, 687-695.
243. Messerlin, A., and Couzi, G. 1942 Epidemie infantile grave a *Salmonella suipestifer*. Bull. Inst. Hyg. Maroc., 2, 15-33.
244. Meyer, K.F., and Holdenried, R. 1949 Rodents and fleas in a plague epizootic in a rural area of California. Puerto Rico J. Public Health Trop. Med., 24, 201-209.
245. Miles, V.I., Howitt, B.F., Gorrie, R., and Cockburn, T.A. 1951 Encephalitis in midwest: V. Western equine encephalomyelitis virus recovered from mites *Dermanyssus americanus* Ewing. Proc. Soc. Exptl. Biol. Med., 77, 395-396.

246. Milzer, A. 1942 Studies on the transmission of lymphocytic choriomeningitis virus by arthropods. J. Infectious Diseases, 70, 152-172.
247. Mitzmain, M.B. 1914 Collected studies on the insect. Transmission of Trypanosoma evansi, and summary of experiments in the transmission of anthrax by biting flies. Public Health Service Hyg. Lab., Bull. 94.
248. Miyajima, M., and Okumura, T. 1917 On the life cycle of the "Akamushi". Kitasato Arch. Exptl. Med., [illegible]
249. Moiser, B. 1945 Modes of transmission of Hansen s disease. Leprosy Rev., 16, 63-66.
250. Moore, J.A., Young, M.D., Hardman, N.H., and Stubbs, T.H. 1945 Studies on imported malarias: 2. Ability of California Anophelines to transmit malarias of foreign origin and other considerations. J. Natl. Malaria Soc., 4, 307-329.
251. Moorehead, S., and Weiser, H.H. 1946 The survival of staphlococci food poisoning strain in the gut and excreta of the house fly. J. Milk Technol., 9, 253-259.
252. Mooser, H., Castañeda, M.R. and Zinsser, H. 1931 The transmission of the virus of Mexican typhus from rat to rat by Polyplax spinulosus. J. Exptl. Med., 54, 567-575.
253. Mooser, H., and Dummer, C. 1930 Experimental transmission of endemic typhus of the southeastern atlantic states by the body louse. J. Infectious Diseases, 46, 170-172.
254. Morgan, H. deR. and Ledingham, J.C.G. 1909 The bacteriology of summer diarrhoea. Proc. Roy. Soc. Med., 2, 133-158.
255. Morrell, C. [illegible] Bacteriology of the cockroach. Brit. Med. J., 2, [illegible]1532.
256. Munoz Rivas, G. 1946 Fleas, soil and leprosy. Primer Congreso Inter-Americano de Medicina, 51pp.
257. Napier, L.E., et al. 1933 The transmission of Kala azar to to hamsters by the bite of the sandfly, Phlebotomus argentipes. Indian J. Med. Research, 21, 299-304.
258. Nauck, E.G., and Zumpt, F. 1941 Versuche zur Uebertragung des epidemischen Fleckfiebers durch die Wanzen Cimex lectularis L. und Triatoma rubrofasciata DeGeer. Zentr. Bakt. Parasitenk. Infekt., I. 147, 376-381.
259. Newton, W.L., and Pratt, I. 1946 Experiments to determine potential mosquito vectors of Wuchereria bancrofti in the continental United States. Am. J. Trop. Med., 26, 699-706.
260 Nicoll, W. 1911 On the varieties of Bacillus coli associated with the housefly (Musca domestica). J. Hyg., 11, 381-389.
261. Nicolle, C., Comte, C., and Conseil, E. 1909 Transmission expérimentale du typhus exanthematique par le pou corps. Compt. rend. acad. sci., Paris, 149, 486-489.
262. Nohr, C.O. 1951 Entomological background of the distribution of murine typhus and murine plague in the United States. Am. J. Trop. Med., 31, 355-372.
263. Nuttall, G.H.F. 1899 On the role of insects, arachnids and myriapods, as carriers in the spread of bacterial and parasitic diseases of man and animals. A critical and historical study. Johns Hopkins Hosp. Repts., 8, 1-155.
264. Nuttall, G.H.F. 1917 Lice and disease. Parasitol., 10, 43-79.
265. Olin, G. 1942 The occurrence of tularemia in Sweden, its origin and manner of spread. Nordisk Hyg. Tidskr., 23, 178-189.

266. Olsofiev, N.G., and Golov, D.A. 1936 Horse flies as transmitters and conservators of tularemia. Animaux pathogenes, 2, 187-226.
267. Olson, T.A., and Rueger, M.E. 1950 Experimental transmission of Salmonella oranienburg through cockroaches. Public Health Repts., 65, 531-540.
268. Ostrokenk, M., and Welch, H. 1942 The housefly as a vector of food poisoning organisms in food producing establishments. Am. J. Public Health, 32, 487-494.
269. Owen, W.L., and Mobley, R.L. 1948 A new species of Torulae occurring in and transmitted by the American cockroach Periplaneta americana (Linn). Food Research, 13, 281-290.
270. Packchanian, A. 1948 The fate of Trypanosoma duttoni in Triatoma. Am. J. Trop. Med., 28, 383-386.
271. Packchanian, A. 1948 The fate of Leishmania donovani and Leishmania tropica in the Reduviid blood-sucking insect, Triatoma. Am. J. Trop. Med., 28, 537-539.
272. Packchanian, A. 1948 The fate of some pathogenic trypanosomes in Triatoma and Ornithodoros. Am. J. Trop. Med., 28, 541-543.
273. Pang, K.H. 1941 Isolation of typhus rickettsia from rat mites during epidemic in an orphanage. Proc. Soc. Exptl. Biol. Med., 48, 266-267.
274. Parker, R.R. Unpublished experiments.
275. Parker, R.R. 1923 Transmission of Rocky Mountain spotted fever by the rabbit tick Haemaphysalis leporispalustris Packard. Am. J. Trop. Med., 3, 39-45.
276. Parker, R.R. 1937 Recent studies of tick-borne diseases made at the United States Public Health Service Laboratory at Hamilton, Montana. Proc. Fifth Pacific Science Cong., 3367-3374.
277. Parker, R.R. 1940 A pathogenic rickettsia from gulf coast tick, Amblyomma maculatum. Proc. Third Int. Cong. Microbiol., 390-391.
278. Parker, R.R. 1942 Ornithodoros ticks as a medium for the transportation of disease agents. Public Health Repts., 57, 1963-1966.
279. Parker, R.R., Brooks, C.S., and Marsh, H. 1929 The occurrence of Bacterium tularense in the wood tick, Dermacentor occidentalis, in California. Public Health Repts., 44, 1299-1300.
280. Parker, R.R., and Davis, G.E. 1938 A filter-passing infectious agent isolated from ticks. II. Transmission by Dermacentor andersoni. Public Health Repts., 53, 2267-2270.
281. Parker, R.R., DePrada, J., Bell, E.J., and Lackman, D.B. 1949 Recovery of Coxiella burnetii from Hyalomma savignyi collected in Spain. Public Health Repts., 64, 1614-1616.
282. Parker, R.R., and Kohls, G.M. 1943 American Q fever: the occurrence of Rickettsia diaporica in Amblyomma americanum in eastern Texas. Public Health Repts., 58, 1510-1511.
283. Parker, R.R., Kohls, G.M., Cox, G.W., and Davis, G.E. 1939 Observations on an infectious agent from Amblyomma maculatum. Public Health Repts., 54, 1482-1484.
284. Parker, R.R., Pickens, E.G., Lackman, D.B., Bell, E.J., and Thraikill, F.B. 1951 Isolation and characterization of Rocky Mountain spotted fever rickettsiae from the rabbit tick Haemaphysalis leporis-palustris Packard. Public Health Repts., 66, 455-463.

285. Parker, R.R., Spencer, R.R., and Francis, E. 1924 Tularemia infections in ticks of the species Dermacentor andersoni Stiles in the Bitterroot Valley, Montana. Public Health Repts., 39, 1057-1073.
286. Parker, R.R., and Steinhaus, E.A. 1943 Salmonella enteritidis: experimental transmission by the Rocky Mountain wood tick Dermacentor andersoni Stiles. Public Health Repts., 58, 1010-1012.
287. Parker, R.R., and Sussman, O. 1949 Spontaneous infection of the brown dog tick, Rhipicephalus sanguineus with Coxiella burnetii. Public Health Repts., 64, 1159-1160.
288. Patino-Camargo, L. 1941 Nuevas observaciones sobre un tercer foco di fiebre petequial (Maculosa) en el hemisferio americano. Bol. Oficiana Sanit. Pan-americana, 20, 1112-1124.
289. Patino-Camargo, L., deZulueta, J., and Toro, G. 1944 Persistence of the virus of the spotted fever of Tobia in Ornithodoros parkeri. Bol. Oficiana Sanit. Pan-americana, 23, 978-980.
290. Patton, W.S. 1931 Insects, ticks, mites, and venomous animals of medical and veterinary importance. Part II. Public Health. H.R. Grubb, Ltd., Croydon. 740pp.
291. Patton, W.S., and Hindle, E. 1927 The development of Chinese Leishmania in Phlebotomus major var. chinensis and P. sergenti. Proc. Roy. Soc., London, Ser. B., 101, 369-390.
292. Paul, J.R. 1947 Poliomyelitis in Japan. Am. J. Hyg., 45, 206-218.
293. Paul, J.R., Trask, J.D., Bishop, M.B., Melnick, J.L., and Casey, A.E. 1941 The detection of poliomyelitis virus in flies. Science, 94, 395-396.
294. Pavlovskii, E.N. 1945 The natural endemicity of tick-borne recurrent fever in the Turkmenian Soviet Republic. Med. Parasitol. and Parasitic Div., 14, 56-59.
295. Pavlovskii, E.N. 1946 A register of the spirochaetes of tick strains of relapsing fever in the USSR and neighbouring countries. Rev. Applied Entomol., 33, 17-18.
296. Pavlovskii, E.N., and Soloviev, V.D. 1940 Experimental study of the circulation of the encephalitis virus within the organism of the tick Ixodes persulcatus. Arch. Sci. Biol., 59, 116-117.
297. Philip, C.B. 1948 Observations on experimental Q fever. J. Parasitol., 34, 457-464.
298. Philip, C.B., Davis, G.E., and Parker, R.R. 1932 Experimental transmission of tularemia by mosquitoes. Public Health Repts., 47, 2077-2088.
299. Philip, C.B., and Hughes, L.E. 1948 The tropical rat mite, Liponyssus bacoti, as an experimental vector of rickettsialpox. Am. J. Trop. Med., 28, 697-705.
300. Philip, C.B., and Jellison, W.L. 1934 The american dog tick as a host of Bacterium tularense. Public Health Repts., 49, 386-392.
301. Philip, C.B., and Kohls, G.M. 1945 Studies on tsutsugamushi disease (Scrub typhus, mite-borne typhus) in New Guinea and adjacent islands. Tsutsugamushi disease with high endemicity on a small south sea island. Am. J. Hyg., 42, 195-203.

302. Phillip, C.B., and Hughes, L.E. 1948 Tropical rat mite Liponyssus bacoti as an experimental vector of rickettsialpox Am. J. Trop. Med. 28 697-705.
303. Pierce, W.D. 1921 Sanitary entomology. Gorham Press, Boston. 518pp.
304. Pinto, C. 1930 Arthropodes parasitos e transmissores de doencas. Pamenta de Mella e Co., Rio de Janeiro. 1. 395pp.
305. Pipkin, A.C. 1943 Experimental studies on the role of filth flies in the transmission of certain helminthic and protozoan infections of man. Theses, Tulane Univ., 44, 9-13.
306. Pipkin, A.C. 1949 Experimental studies on the role of filth flies in the transmission of Endamoeba histolytica. Am J. Hyg., 49 255-275.
307. Pollard, M., Liversay, H.R., Wilson, D.J., and Woodland, J.C. 1946 Experimental studies with Bullis fever. Am. J. Trop Med., 26 175-187.
308. Prince, F.M., and Wayson, N.E. 1947 Plague. The survival of the infection in fleas or hibernating [illegible] squirrels. Public Health Repts., 62, 1167-1168.
309. Proust, A. 1894 Pustule maligne transmise par des peauxde chevres venant de chine, etc. Bull. Acad. Med., 30, 57-66.
310. Reed, W. 1900 The etiology of yellow fever. Phila. Med. J., 6, 790-796.
311. Reeves, W.C., Hammon, W.McD., Furman, D.P., McClure, H.E., and Brookman, B. 1947 Recovery of western equine encephalomyelitis virus from wild bird mites (Liponyssus sylviarum) in Kern County, California. Science, 105 411-412.
312. Reitler, R., and Menzel, R. 1946 Some observations on Salmonella strains in dogs, mice and ticks. Trans. Roy. Soc. Trop. Med. Hyg., 39, 523-527.
313. Rendtorff, R.C., and Francis, T. 1943 Survival of the Lansing strain of poliomyelitis virus in the common house fly, Musca domestica. J. Infectious Diseases 73 198-205.
314. Rickard, E.R. 1951 The survival time of the rickettsias of murine typhus in infected flea feces. Am. J. Trop. Med., 31, 306-310.
315. Ricketts, H.T. 1906 The transmission of Rocky Mountain spotted fever by the bite of the wood tick (Dermacentor occidentalis). J. Am. Med. Assoc. 47, 358.
316. Ricketts, H.T., and Wilder, R.M. 1910 The transmission of the typhus fever of Mexico (Tabardillo) by means of the louse (Pediculus vestimenti). J. Am. Med. Assoc., 54, 1304-1307.
317. Riley, W.A., and Johannsen, O.A. 1932 Medical entomology. 1st ed. McGraw-Hill Book Co., New York. 476pp.
318. Riley, W.A., and Johannsen, O.A. 1938 Medical entomology. 2nd ed. McGraw-Hill Book Co., New York. 483pp.
319. Robertson, M. 191[illegible] Notes on certain aspects of the development of Trypanosoma gambiense in Glossina palpalis. Proc. Roy. Soc., B, 85, 241-248.
320. Roca-Garcia, M. 1944 The isolation of three neurotropic viruses from forest mosquitoes in eastern Colombia. J. Infectious Diseases, 75, 160-169.
321. Root, F.M. 1921 Experiments on the carriage of intestinal protozoa of man by flies. Am. J. Hyg., 1, 131-153.

322. Rosenholz, H. 1927 Die Rolle der Wanzen in Epidemiologie des Rückfallfiebers. Zentr. Bakt. Parasitenk. Infekt., I Orig., 102, 179-213.
323. Ross, R. 1898 Pigmented cells in mosquitoes. Brit. Med. J., 1, 550-551.
324. Ross, R.H., and Milne, A.D. 1904 Tick fever. Brit. Med. J., 2, 1453-1454.
325. Ross, R.W. 1950 The survival of yellow fever virus in refrigerated mosquitoes. Ann. Trop. Med. Parasitol., 44, 299-308.
326. Roubaud, E. 1918 Le rôle de mouche dan la dispersion des amibes dysenteriques autre protozaires intestinaux. Bull. Soc. Path. Exot., 11, 166-171.
327. Roubaud, E, Lepine, P., Treillard, M., and Sauter, V. 1941 Infection experimentale de culicides (aedines) europeens avec le virus de encephalmyelite equine amercaine, type Venezuela. Bull. Soc. Path. Exot., 34, 130-133.
328. Ruhland, H.H., and Huddleson, I.F. 1941 The role of one species of cockroach and several species of flies in the dissemination of Brucella. Am. J. Vet. Research, 2, 371-372.
329. Sabin, A.B., and Ward, R. 1942 Insects and epidemiology of poliomyelitis. Science, 95, 300-301.
330. St. John, J.H., Simmons, J.S., and Reynolds, F.H.K. 1930 The survival of various microorganisms within the gastro-intestinal tract of Aedes aegypti. Am. J. Trop. Med., 10, 237-241.
331. Sambon, L.W., and Low, G. 1900 The malaria experiments in the Campagna. Brit. Med. J., 2, 1679-1682.
332. Saunders, D.A. 1904 Musca domestica, a vector of bovine mastitis. J. Am. Med. Assoc., 97, 120-123.
333. Saunders, D.A. 1904 Hippelates flies as vectors of bovine mastitis. J. Am. Med. Assoc., 97, 306-308.
334. Savoor, S.R., Vahia, N.S., and Soman, D.W. 1948 Typhus in Bombay. 3. Identification of strains. Indian Med. Gaz., 83, 70-74.
335. Schuberg, A., and Boing, W. 1914 Ueber die Uebertragung von Krankheiten durch einheimische stechende Insekten. Arb. Kaiserl. Gesundh., 47, 491-512.
336. Schuberg, A., and Kuhn, P. 1912 Ueber die Uebertragung von Krankheiten durch einheimische stechende Insekten. Arb. Kaiserl. Gesundh., 40, 209-234.
337. Scott, J.R. 1917 Studies upon the common house fly (Musca domestica). II. Isolation of B. cuniculicida, a hitherto unreported isolation. J. Med. Research, 37, 121-124.
338. Seargent, A. 1938 Fievre récurrente Hispano-Nord-Africaine. Arch. Inst. Pasteur Algérie, 16, 403-415.
339. Sen, S.K., and Minett, F.C. 1944 Experiments on the transmission of anthrax through flies. Indian J. Vet. Sci. Animal Husbandry, 14, 149-158.
340. Shannon, R.C., Whitman, L., and Franca, M. 1938 Yellow fever virus in jungle mosquitoes. Science, 88, 110-111.
341. Shaugnessy, H.J., and Milzer, A. 1939 Experimental infection of Dermacentor andersoni Stiles with the virus of lymphocytic choriomeningitis. Am. J. Public Health, 29, 1103-1108.

342. Shooter, R.A., and Waterworth, P.M. 1944 A note on the transmissability of hemolytic streptococcal infection by flies. Brit. Med. J., no. 4337, 247-248.
343. Shu-Hsian, C. 1949 Longevity of Rickettsia prowazeki in louse feces. Schweiz. Zeitschr. Path. u. Bact., 12, 508-512.
344. Sieyro, L. 1942 Die Hausfliege (Musca domestica) als Ueberträger von Entamoeba histolytica und anderen Darmprotozoen. Deut. Trop. Z., 46, 361-372.
345. Simmonds, M. 1892 Fliegen und Choleraubertragung. Deut. Med. Wochschr., no. 41, 931.
346. Simmons, J.S. 1941 The transmission of malaria by the Anopheles mosquitoes of North America. Pub. Am. Assoc. Advancement Sci., 15, 113-130.
347. Simmons, J.S., St. John, J.H., and Reynolds, F.H.K. 1931 Experimental studies of dengue. Philippine J. Sci., 44, 1-252.
348. Skidmore, L.V. 1932 The transmission of fowl cholera to turkeys by the common house fly, with brief notes on the viability of fowl cholera microorganisms. Cornell Vet., 22, 281-285.
349. Smith, D.J.W., and Derrick, E.H. 1940 Studies in the epidemiology of Q fever. I. The isolation of six strains of Rickettsia burnetii from the tick Haemaphysalis humerosa. Australian J. Exptl. Biol. Med. Sci., 18, 1-8.
350. Smith, M.G., et al. 1941 Experiments on the role of the chicken mite, Dermanyssus gallinae, and the mosquito in the epidemiology of St. Louis encephalitis. Med. News Letter, 11, 14-18.
351. Smith, M.G., Blattner, R.J., and Heys, F.M. 1944 The isolation of the St. Louis encephalitis virus from chicken mites (Dermanyssus gallinae) in nature. Science, 100, 362-363.
352. Smith, M.G., Blattner, R.J., and Heys, F.M. 1945 Further isolation of St. Louis encephalitis virus: congenital transfer of virus in chicken mites (Dermanyssus gallinae). Proc. Soc. Exptl. Biol. Med., 59, 136-138.
353. Smith, R.O.A., and Murkirjee. 1936 Bionomics of Phlebotomus argentipes, I, II. Indian J. Med. Research, 24, 295-308, 557-562.
354. Smith, T., and Kilbourne, F.E. 1893 Investigations into the nature, causation, and prevention of Texas or southern cattle fever. U.S. Dept. Agr. Bur. Animal Ind. Bull., I, 177pp.
355. Smithburn, K.C., Haddow, A.J., and Gillett, J.D. 1948 Rift Valley fever. Isolation of the virus from wild mosquitoes. Brit. J. Exptl. Path., 29, 107.
356. Smithburn, K.C., Haddow, A.J., and Lumsden, W.H.R. 1949 An outbreak of Sylvan yellow fever in Uganda with Aedes (Stegomyia) africanus Theobald as principal vector and insect host of the virus. Ann. Trop. Med. Parasitol., 43, 74-89.
357. Snyder, J.C., and Wheeler, C.M. 1945 The experimental infection of the human body louse, Pediculus humanus corporis, with murine and epidemic louse-borne typhus strains. J. Exptl. Med., 82, 1-19.
358. Sofiev, M.S., and Leitman, M.Z. 1946 On the possibility of transmission of spirochaetes of louse-borne relapsing fever by ticks and of spirochaetes of tick-borne relapsing fever by lice. Med. Parasitol. and Parasitic Dis. Moscow, 15, 81-84.

359. Spielman, M. and Haushalter, M. 1887 Dissemination du bacilli de la tuberculose par la mouch. Compt. rend. acad. sci., Paris 105, 352-353.
360. Starzyk, J. 1936 Vitalite toxicite et pouvoir d'immunisation de Rickettsia prowazeki conservees hors de l'organisme du pou en milieu liquide et en milieu sec. Compt. rend. soc. biol. 123, 1221-1225.
361. Steinhaus, E.A. 1941 A study of the bacteria associated with thirty species of insects. J. Bact., 42, 757-790.
362. Steinhaus, E.A. 1944 Unpublished data.
363. Steinhaus, E.A. 1947 Insect microbiology. Comstock Publishing Co. Inc. New York, 763pp.
364. Stewart, W. (Maj) 1944 Viability of dysentery bacilli and transmission by flies in North Africa. J. Roy. Army Med. Corps 83, 42-46.
365. Stratman Thomas, W.K., and Baker, F.C. 1936 Anopheles barbari Coquillet as a vector of Plasmodium vivax Grassi and Feletti. Am. J. Hyg., 24, 182-183.
366. Sulkin, S.E. 1945 Recovery of equine encephalomyelitis virus (western type) from chicken mites. Science, 101, 381-383.
367. Sullivan, T.D., McGregor, T., Eads, R.B., and Dorland, J.D. 1949 Incidence of Trypanosoma cruzi, Chagas, in Triatoma (Hemiptera, Reduviidae) in Texas. Am. J. Trop. Med., 29, 453-458.
368. Swaminath, C.S., Shortt, H.E., and Anderson, L.A.P. 1942 Transmission of Indian kala azar to man by the bites of Phlebotomus argentipes. Indian J. Med. Research, 30, 473-477.
369. Syverton, J.T., and Berry, G.P. 1941 Hereditary transmission of the western type of equine encephalomyelitis virus in the wood tick, Dermacentor andersoni. J. Exptl. Med., 73, 507-530.
370. Syverton, J.T., and Fischer, R.G. 1950 The cockroach as an experimental vector of the virus of spontaneous mouse encephalomyelitis (Theiler). Proc. Soc. Exptl. Biol. Med., 74, 296.
371. Syverton, J.T., Fischer, R.G., Smith, S.A., Dow, R.P., and Schoot, H.F. 1952 The cockroach as a natural extrahuman source of poliomyelitis virus. Federation Proceedings 11, 483.
372. Tanaka, K. 1899 Ueber Aetiologie and Pathogenese der Kedanikrankheit. Central. Bakt., I Abt., 26, 432-439.
373. Tejera, E. 1926 Les blattes envisagées comme agentes de dissemination des germes pathogènes. Compt. rend. soc. biol. 95, 1382-1384.
374. Thompson, G.A., Howitt, B.F., Gorrie, R., and Cockburn, T.A. 1951 Encephalitis in midwest. VI. Western equine encephalomyelitis virus isolated from Aedes dorsalis Meigen. Proc. Soc. Exptl. Biol. Med., 78, 289-290.
375. Toda, T. 1923 Cholera and the ship cockroach. J. Hyg., 21, 359-361.
376. Toepfer, H. 1916 Zur Urache und Uebertragung des Wolhynischn Fiebers. Munchen. med. Wochnschr., 63, 1495-1496.
377. Toomey, J.A., Takacs, W.S., and Tischer, L.A. 1941 Poliomyelitis virus from flies. Proc. Soc. Exptl. Biol. Med., 48, 637-639.

378. Topley, and Wilson, G.S. 1946 Principles of bacteriology and immunity. 3rd ed. The Williams & Wilkins Co., Baltimore. 970pp.
379. Torrey, J.C. 1912 Numbers and types of bacteria carried by city flies. J. Infectious Diseases, 10, 166-177.
380. Tovar, R.M. 1947 Infection and transmission of Brucella by ectoparasites. Am. J. Vet. Research, 8, 138-140.
381. Trask, J.D., Paul, J.R., and Melnick, J.L. 1943 The detection of poliomyelitis virus in flies collected during epidemics of poliomyelitis. I. Methods, results, and types of flies involved. J. Exptl. Med., 77, 531-544.
382. Traub, R., Frick, L.P., and Diercks, F.H. 1950 Observations on the occurrence of Rickettsia tsutsugamushi in rats and mites in the Malayan jungle. Am. J. Hyg., 38, 435.
383. Vallejo-Freire, A. 1947 Transmission do virus da febre maculose mexicana por Amblyomma striatum Koch, 1844. Mem. Inst. Butantan, 20, 107-112.
384. Varela, G., and Olarte, J. 1946 Transmission of Salmonella enteritidis by Pulex irritans and Ctenocephalus canis. Science, 104, 104-105.
385. Varela, G., and Rebelo, R.P. 1950 Antibiotic properties for Salmonella enteritidis in Aedes aegypti. Rev. Soc. Mexicana Hist. Nat., 11, 29-33.
386. Veeder, M.A. 1898 Flies as spreaders of disease in camps. N.Y. Med. Record, Sept. 17, 429-430.
387. Volferz, A.A., Kolpakov, S.A., and Flegontoff, A.A. 1934 The role of ectoparasites in the tularemic epizootic of the ground squirrels. Rev. Microbiol. Epidemiol. Parasitol., 13, 103-116.
388. Waller, E.F. 1940 Tularemia in Iowa cottontail rabbits (Sylvilagus floridanus mearnsi) and in a dog. Vet. Student, 2, 54,55,73.
389. Waddell, M.B. 1945 Persistence of yellow fever virus in mosquitoes after death of the insect. Am. J. Trop. Med., 25, 329-332.
390. Waddell, M.B., and Kumm, H.W. 1948 Haemagogus capricorni Lutz as a laboratory vector of yellow fever. Am. J. Trop. Med., 28, 247-252.
391. Waddell, M.B., and Taylor, R.M. 1947 Studies on the cyclic passage of yellow fever virus in South American mammals and mosquitoes. III. Further observations on Haemagogus equinus as a vector of the virus. Am. J. Trop. Med., 27, 471-476.
392. Watson, R.B. 1945 Observations on the transmissibility of strains of Plasmodium vivax from Pacific war areas by Anopheles quadrimaculatus. Am. J. Trop. Med., 25, 315-321.
393. Wedberg, S.E., Brandt, C.D., and Helmboldt, C.F. 1949 The passage of microorganisms through the digestive tract of Blaberus cranifer mounted under controlled conditions. J. Bact., 58, 573-578.
394. Weller, B., and Graham, G.M. 1930 Relapsing fever in central Texas. J. Am. Med. Assoc., 95, 1834-1835.
395. Weyer, F. 1948 Rickettsia wolhynica and the diagnosis of trench fever by the louse test. Zentr. f. Bakt., 152, 403-414.

396. Weyer, F. 1948 Artificial inoculation of ticks with rickettsiae and other agents. Zentr. f. Bakt., 152, 449-457.
397. Weyer, F. 1949 Experiments in the transmission of rickettsiae to the mouse flea. Zentr. f. Bakt., 153, 115-121.
398. Whitman, L. 1937 The multiplication of the virus of yellow fever in Aedes aegypti. J. Exptl. Med., 66, 133-143.
399. Wisseman, C.L., Jr. 1945 Relapsing fever in Denton County, Texas, Report on finding the tick, Ornithodoros turicata, naturally infected. Am. J. Trop. Med., 25, 339-342.
400. Wolman, B., and Wolman, M. 1945 Studies of the biological properties of Spirochaeta recurrentis in the Ethiopian high plateau. Ann. Trop. Med. Parasitol., 39, 82-93.
401. Wood, F.D. 1934 Natural and experimental infection of Triatoma protracta and mammals in California with American human trypanosomiasis. Am. J. Trop. Med., 14, 497-517.
402. Wood, S.F. 1942 The persistence of Trypanosoma cruzi in dead cone-nosed bugs (Hemiptera, Reduviidae). Am. J. Trop. Med., 22, 613-621.
403. Wood, S.F. 1943 Observations on vectors of Chaga's disease in the United States. II. Arizona. Am. J. Trop. Med., 23, 315-320.
404. Wood, S.F. 1950 The distribution of California insect vectors harboring Trypanosoma cruzi Chagas. Bull. So. Calif. Acad. Sci., 49, 98-100.
405. Wood, S.F. 1951 Development of California Trypanosoma cruzi in bat bedbug. J. Parasitol., 37, 330-331.
406. Young, C.W., and Hertig, M. 1927 The development of flagellates in Chinese sand flies (Phlebotomus) fed on hamsters infected with Leishmania donovani. Proc. Soc. Exptl. Biol. Med., 23, 611-615.
407. Young, M.D. 1937 Cockroaches as carriers of Giardia cysts. J. Parasitol., 23, 102-103.
408. Young, M.D., and Burgess, R.W. 1947 The transmission of Plasmodium malaiae by Anopheles maculipennis Freeborni. Am. J. Trop. Med., 27, 39-40.
409. Young, M.D., and Burgess, R.W. 1952 Susceptibility of Anopheles quadrimaculatus to Korean vivax malaria. Public Health Repts., 67, 14-16.
410. Young, M.D., Stubbs, T.H., Moore, J.A., Ehrman, F.C., Hardman, N.F., Ellis, J.M., and Burgess, R.W. 1945 Studies on imported malarias: 1. Ability of domestic mosquitoes to transmit vivax malaria of foreign origin. J. Natl. Malaria Soc., 4, 127-131.
411. Zinsser, H., and Castaneda, M.R. 1931 Studies on typhus fever. VIII. Ticks as a possible vector of the disease from animals to man. J. Exptl. Med., 54, 11-26.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE EFFECT OF PRESSURE ON THE PERSISTENCE (SURVIVAL) OF ORGANISMS

TABLE P THE EFFECT OF PRESSURE ON THE SURVIVAL OF MICROORGANISMS

Factor(s)	Survival	Reference	
<u>Escherichia coli</u>			
5,000 atm. hydrostatic pressure	45 min.	Basset	1937
10,000 bolts in an evacuated tube	1 hr.	Dognon	1930
500 lb./sq. in. of argon	0-7% burst	Fraser	1951
900 " " " " "	30-46% burst	"	"
500 " " " " nitrogen	14-20% burst	"	"
900 " " " " "	75% burst	"	"
250 " " " " nitrous oxide	0-5% burst	"	"
500 lb./sq. in. of nitrous oxide	54-78% burst	"	"
750 lb./sq. " " " oxide	53-56% burst	"	"
500 lb./sq. in. of carbon dioxide	48-56% burst	"	"
20 ml. of log-phase cult., 37C, 500 lb./sq. in. of nitrous oxide	54-78% burst	"	"
5,000 lb./sq. in. at high temp.	Increases rate of disinfection	Johnson	1946
5,000 lb./sq. in. at low temp.	Decreases rate of disinfection	"	"
In presence of quinine 1,000-2,000 lb./sq. in.	Decreases rate of disinfection	"	"
In presence of quinine 4,000-6,000 lb./sq. in.	Increases rate of disinfection	"	"
1,000 lb./sq. in. at low temp.	Retards growth	"	"
1,000 lb./sq. in. at high temp.	Accelerates growth	"	"
Hydrostatic pressure of 1,000 lb./sq. in., below 37C	Retards growth	Lewin	1946
Hydrostatic pressure of 1,000 lb./sq. in., above 37C	Accelerates growth	"	"
<u>Aerobacter aerogenes</u>			
85-100 thousand lb./sq. in.	4-5 min.	Hite	1914
50-65 " " " "	10 min.	"	"
30-45 " " " "	1 hr.	"	"
<u>Salmonella typhosa</u>			
5,000 atm. hydrostatic pressure	45 min.	Basset	1937
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
40-45 thousand lb./sq. in.	Killed	Hite	1914
<u>Salmonella paratyphi A & B</u>			
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
<u>Salmonella typhimurium</u>			
High tension, low pressure ultraviolet lamp in test tube of liquid cult.	5 min.	Gilles	1935

TABLE Pr (CONT'D) THE EFFECT OF PRESSURE ON THE SURVIVAL OF MICROORGANISMS

Factor(s)	Survival	Reference	
S. typhosa bacteriophage 4500 atm. of pressure	Resists	Basset	1937
Bacillus subtilis bacteriophage 4500 atm.	Resists	"	"
Bacillus megatherium bacteriophage 4500 atm.	Resists	"	"
Rabies virus 4000 atm	30 min.	"	"
Herpes virus 7000 atm.	" "	"	"
Yellow fever virus 3000 atm.	" "	"	"
Foot-and-mouth virus 3000 atm.	" "	"	"
Encephalomyelitis virus <6500 atm.	" "	"	"
Smallpox virus 4500 atm.	45 min.	Waeser	1937
Mold 10,000 volts in an evacuated tube	1 hr.	Dognon	1930
Yeast High tension, low pressure ultraviolet lamp in a test tube of liquid cult.	10-15 min.	Gilles	1935
High tension, low pressure ultraviolet lamp over a gelatin plate	More time	"	"
85 thousand lb./sq. in.	5 min.	Hite	1914
30-35 " " " "	1 hr.	"	"
Bacteria general 6000 atm. pressure	Non-spore formers 14 hr.	Larson	1918
12,000 atm. pressure	Spores 14 hr.	"	"
6000 atm.	Non-spore formers destroyed	Waeser	1937
400 atm. hydrostatic pressure, 30C	Marine bacteria 4 d.	Zobell	1950
600 atm. hydrostatic pressure, 30C	" " " "	"	"

TABLE P (CONT'D) THE EFFECT OF PRESSURE ON THE SURVIVAL OF MICROORGANISMS

Factor(s)	Survival	Reference	
Streptococcus faecalis			
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
Streptococcus cremoris			
85-100 thousand lb./sq. in.	4-5 min.	Hite	1914
50-65 " " " "	10 min.	"	"
30-45 " " " "	1 hr.	"	"
Micrococcus aureus			
Liquid, 3000 atm. pressure, ordinary temp.	Recov. ≠, 45 min.	Basset	1932
Liquid, 6000 atm. " ordinary temp.	" 0, time not given	"	"
Micrococcus spp.			
5000 atm. hydrostatic pressure	45 min.	"	"
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
Mycobacterium tuberculosis			
Liquid, 3000 atm., ordinary temp.	Recov. ≠, 45 min.	Basset	1932
Liquid, 6000 atm., " temp.	" 0, time not given	"	"
Pasteurella sp.			
> 2000 atm.	30 min.	Basset	1937
Bacillus subtilis			
Liquid at 17,600 atm., ordinary temp.	Recov. ≠, 45 min.	Basset	1932
20,000 atm. hydrostatic pressure	>45 min.	"	1937
Bacillus anthracis			
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
Proteus vulgaris			
10,000 volts in an evaccuated tube	1 hr.	"	"
Serratia marcescens			
Liquid, 3000 atm., ordinary temp.	Recov. ≠, 45 min.	Basset	1932
Liquid, 6000 atm., " temp.	" 0, time not given	"	"
10,000 volts in an evaccuated tube	1 hr.	Dognon	1930
85-100 thousand lb./sq. in.	4-5 min.	Hite	1914
50-65 " " " "	10 min.	"	"
30-45 " " " "	1 hr.	"	"
Corynebacterium diphtheriae			
40-45 thousand lb/sq. in.	Killed	"	"
Diplococcus pneumoniae			
5000 atm. hydrostatic pressure	45 min.	Basset	1937
Micrococcus bacteriophage			
1000, atm.	Recov. 10^6-10^8, 30 min.	"	"

References (Pressure)

1. Basset, J., and Macheboeuf, M.A., 1932 Resistance of bacteria to very high pressure. Compt. Rend. Acad. Sci., 195, 1431-1433.

2. Basset, J., and Macheboeuf, M., Wolchan, E. 1937 Researches on pathogenic microbes and their toxins, on invisible viruses, bacteriophages and malignant tumors. Ann. Inst. Pasteur, 58, 58-77.

3. Dognon, A. 1930 Resistance of bacteria to low air pressure; possibilities of biological study of slightly penetrating rays. Compt. Rend. Soc. Biol., 103, 886-887.

4. Fraser, Dean 1951 Bursting bacteria by release of gas pressure. Nature, London, 167, 33-34.

5. Gilles, E. 1935 Bacilli sterilized by means of high tension lamp which emits ultraviolet rays. Compt. Rend. Soc. Biol., 118, 1440-1442.

6. Hite, B. H., Giddings, N.S., and Weakley, C. E., Jr., 1914 West Va. Agr. Exp. Sta. Bull.

7. Johnson, F.H., and Lewin, I. 1946 Bacterium coli: disinfection in relation to temperature, hydrostatic pressure, and quinine. J. Cellular Comp. Physiol., 28, 23-45.

8. Johnson, F.H., and Lewin, I. 1946 The disinfection of Escherichia coli in relation to temperature, hydrostatic pressure and quinine. J. Cellular Comp. Physiol., 28, 47-75.

9. Johnson, F.H., and Lewin, I. 1946 Influence of pressure, temperature, and quinine on rates of growth and disinfection of Escherichia coli in logarithmic growth phase. J. Cellular Comp. Physiol., 28, 77-97.

10. Larson, W.P., Hartzell, T.B., and Diehl, H.S. 1918 Effect of high pressures on bacteria. J. Infec. Dis., 22, 271.

11. Lewin, I., and Johnson, F.H. 1946 The relation of pH and quinine to growth and disinfection rates of Escherichia coli. J. Bact., 51, 602.

12. Waeser, B. 1937 Reactions at highest pressures and apparatus therefor. Chem.-Zeitung., 61, 534.

13. Zobell, C.E., and Oppenheimer, C.H. 1950 Some effects of hydrostatic pressure on the multiplication and morphology of marine bacteria. J. Bact., 60, 771-781.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE EFFECT OF RADIATION ON THE PERSISTENCE (SURVIVAL) OF ORGANISMS

TABLE R1 THE EFFECT OF RADIATION ON BACILLUS SPECIES

Factor (s)	Survival	Reference	
ULTRAVIOLET			
B. anthracis			
Uv.	Killed	Phelps	1939
Uv. 452 erg/mm^2 at 2537A^o	Reduc. 90%	Sharp	1939
Uv.	Chief factor in sunlight and artifical light	Ward	1894
B. subtilis			
Uv. rays 2650 A^o	Little difference in resistance of veget. and spore forms	Duggar	1934
Uv.	Inoc. innumerable, Recov. 42, 3 min.	Hart	1939
Uv. 62000 erg/cm^2	Killed	"	1944
Uv.	"	Phelps	1939
Uv. 62000 erg/cm^2	Lethal	Sharp	1940
Uv.	30 min.	Tanner	1930
Uv.	More susceptible than Staph., Diplococcus, and influenza virus	Wells	1945
Uv. 1100-1400 A^o	Slight germicidal action	McCullough	1945
B. megatherium			
Uv. rays 2650 A^o	Little difference in resistance of veget. & spore forms	Duggar	1934
Uv. 0.873	5 sec.	Hercik	1936
Uv.	More resistant than B. subtilis	Laurens	1938
Uv.	30 min.	Tanner	1930
B. sp.			
Uv. 2537 A^o	Kills	Lea	1940
LIGHT			
B. anthracis			
Sunlight	Easily destroyed	Arloings	1885
Artificial light	" "	"	"
Bouillon, 35-39C, sun	2 hr.	"	"
Diffuse sunlight, dry	Reduc. 50%, few mo., 100% in 23 yr.	Graham-Smith	1930
Sunlight, nutrient medium air	24 hr.	Roux	1887
Sunlight " " no air	>83 hr.	"	"
Sunlight, 40C	Inoc. 1 loop 24 hr. cult., Recov. 0, 15 min.	Ukil	1927
Sunlight	Partly killed, 1-1½ hr.	Ward	1890-94
Gelatin agar plates, 18C	2-6 hr.	"	1892-93
Sunlight	8 hr.	Weinzirl	1914
Blood from diseased cow dried on gauze in diffuse sunlight	Killed guinea pigs in 36 hr.	McCullough	1945
B. subtilis			
Sunlight	8 hr.	Weinzirl	1914
B. megatherium			
Sunlight	" "	"	"

TABLE R1 (CONT'D) THE EFFECT OF RADIATION ON BACILLUS SPECIES

Factor(s)	Survival	Reference	
ULTRASONIC			
B. anthracis			
Saline, ultrasounds frequency 320 kc.	Inoc. 3.5×10^9, Reduc. 97.5%, 45 min.	Grabar	1945
B. megatherium			
Ultrasounds frequency 320 kc.	Inoc. 4.4×10^8, Reduc. 99.7%, 45 min.	"	
OTHER RADIATION			
B. anthracis			
10,000 v. in evacuated tube	1 h.	Dognon	1930
B. subtilis			
High voltage cathode rays	1 sec.	Porter	1947

TABLE R2) THE EFFECT OF RADIATION ON BACTERIA (GENERAL)

Factor(s)	Survival	Reference	
ULTRAVIOLET			
U.v. on water	Few sec.	Bujwid	
" " bacteria of air	Kills	Buttolph	1945
" action on gram-positive bacteria	Became gram-negative	Cernovodeanu	
Uv. action on acid-fast	Lost resistance	"	
Short wave lengths on water borne bact.	Kills	Coblentz	1924
Uv. rays 1250-1600 A°	More easily destroyed by heat	Curran	1938
" " 26-52 A°	Reduc. 99.98%, 260 min.	Duggar	1934
" at 254 mm.	Maximum effect.	Gartner	1947
" on pathogenic org. in dist. water & different salt solutions.	Type of salt had no effect except in few cases	Gutfeld	1928
Uv. 3000 A°	Kills	Hollaender	1943
House dust with Uv.	Recov. 225/10 cu. ft., 30 min.	"	
Uv.	Resistance lower in non-pigmented. Org. which excrete pigment to medium have low resistance	Ishmenetskii	1946
Uv. 2537 A°, with room lights on, in air.	Respiratory org. recov. 0.5%, 2 hr.	Knowles	1950
Uv. partial radiation	Not given	Lidwell	1946
" absorption	Bactericidal	"	
" open agar plate	15 min.	Miller	1948
" 20 microwatts/sq. cm. 2537 A°, in air.	Recov. adequate disinfection, 250-500 sec.	Mudd	1944
Uv. 30 microwatts/sq. cm. 2537 A°, in air	Recov. same, 167-334 sec.	"	
Water contaminated with clay and turf, Uv.	Not so easily ster. as clear water	Chor-Blom	
Uv. rays	The bactericidal effect not due to action of HNO_2, O_3 or water but to direct action of rays on protoplasm	"	
" "	Older resting cells more resistant than younger cells in cell division	Oster	1934
" "	Reduc. 80%, 0.2 sec.	Perkins	1929
" "	Larger forms more resistant		
" " on air	Bactericidal	Rentschler	1940
" " "	1/10 as resistant in air as in agar. More resistant at high R.H.; Less resistant if first exposed to heat.	"	1941
Low press. Hg. discharge in Uv. transmitting glass	35% killed/4 tantalum units.	"	1942

TABLE R21 (CONT'D) THE EFFECT OF RADIATION ON BACTERIA (GENERAL)

Factor(s)	Survival	Reference
ULTRAVIOLET		
Low press. Hg discharge in quartz	36.0% killed/4 tantalun units	Rentschler 1942
Open arc beta u carbon	46.6% killed " " units	" "
Quartz arc	36.0% killed " " units	" "
Uv. in air condition system	Bactericidal	Rentschler 1940
"	"	Robertson 1940
Uv. on thermobacteria	Inoc. 71,000,000, Reduc. 99%	Schnegg 1936
Uv. exposure on water	Inoc. 2,000/cc, Recov. 0, 25 sec.	Schwarz 1911
Uv. on water bact. in raw water	Inoc. 300, Recov. 0, 15 sec.	" "
Uv. exposure on water, flow 1 liter/min.	Recov. 0, 6 sec.	" "
Uv. on spore bact. in raw water	Inoc. 1500/cc, Recov. practically 0, 15 sec.	" "
Uv.	Twice as much energy needed to kill spore as veg. form	Sharp 1939
Uv.	Not given	Sterckx 1935
Uv.	The destruction depends on surrounding factors	Vaindrakh 1939
Uv. on high vacuum	Lethal	Wells 1929
Uv. dry air	More germicidal in dry air	" 1940
Uv.	The greater the R.H. the less the killing	Wells 1942
Uv. in air	Kills	Wells 1943
Uv. 0.002 foot watt min./ cu. ft. of air	Lethal effect	Wells 1945
Uv.	10-20x more germicidal in dry air	Whisler 1940
Uv.	Energy for killing in uv., 100x greater than x-ray	Wyckoff 1932
Uv.	Most bactericidal at 2650 Å	Porter 1947
Uv.	When uv. is used bact. ct. 5x greater than when not used in surgery	Kraissl 1942
Uv. 2500-3000Å	Bactericidal	Rahn 1932
Carbon arc source, 3287-2265Å	Bactericidal	Downes 1877
Hanaver Hg lamp on gram +	Recov. 0, 1-2 min.	Gartner 1947
" " " " " -	Recov. 0, 15-30 sec.	Gartner 1947
LIGHT		
Sunlight in cities	Important in destruction	Clement 1886
Long continued, strong, direct sunlight	Bactericidal	DeLarequette 1918

TABLE R21 (CONT'D) THE EFFECT OF RADIATION ON BACTERIA (GENERAL)

Factor(s)	Survival	Reference	
LIGHT (cont'd)			
Sunlight	Lethal effect depending on oxidation	Downes	1877
"	Destroys	"	1878
Tissue made anemic by press. in sunlight, 4mm. depth	Recov. 0	Emmerson	1933
Sunlight	Kills best between 8AM-3PM	Meader	1926
" , waves shorter than 3100 A°	Lethal	"	"
Subnormal sunshine and ppt.	Long survival of infect-agents in air	Meissner	194[illegible]
Sunlight	Not given	Rossi	1924
Sun on pathogenes	" "	Grancher	1889
Sunlight on sea bact.	Recov. 26 bact./cc at surf, 420/cc at 25 meters depth	Schmidt-Nielson	1901
Direct sunlight, 110-120F	Destruction of org.	Sternberg	1894
Sunlight	Not given	Ward	1894-95
Light	Bactericidal	Wells	1940
Direct sunlight, 2mm. deep, sea bact.	Inoc. 164/cc, Recov. 76/cc, 2 hr.	Zobell	1935
Direct sunlight, 10mm. deep, sea bact.	Inoc. 163/cc, Recov. 126/cc, 2 hr.	"	"
Direct sunlight, surf	Inoc. 238, Recov. 121, 7 hr.	"	"
Unexposed to sun, "	Inoc. 241, Recov. 190, 7 hr.	"	"
" " " 10cm.	Inoc. 235, Recov. 188, 7 hr.	"	"
" " " 20cm.	Inoc. 217, " 217, 7 hr.	"	"
Water 50cm. in cylinders in sun, surface	Inoc. 4900, Recov. 0, 6 hr.	T. & W.	1946
middle	Inoc. 4510, Recov. 2, 6 hr.	"	"
bottom	Inoc. 6781, " 8, 6 hr.	"	"
Water 50cm. in cylinders in dark, surface	Inoc. 4900, Recov. 7261, 6 hr.	"	"
middle	Inoc. 4510, " 9051, 6 hr.	"	"
bottom	Inoc. 6781, " 12591, 6 hr.	"	"
X-RAY			
Roentgen ray tubes	10-60 min.	Bean	1903
Soft roentgen radiation	Gram-neg. more sensitive Spore-formers less resistant	Gastaldi	1949
Roentgen rays	Incidental morphological	Rozhin-Kokhanii	1948

TABLE R21 (CONT'D) THE EFFECT OF RADIATION ON BACTERIA (GENERAL)

Factor(s)	Survival	Reference	
ULTRASONIC			
Sonic energy	Proteins interfer with germicidal action	Beckwith	1936
Ultrasonic waves	Death of cell	Kvasnikov	1941
" vibrations	Disintergration	Loiseleur	1945
OTHER RADIATION			
Electric energy	Not given	Sugiyama	1951
Continous current at 260-320 milliamperes on bouillon, 98.5C	10 min.	Zeit	1901
Continous current 48 milli-amperes, 37C	2-3 hr.	"	"
Continous current 100 " amperes,	75 min.	"	"
Photosensitivity	Gram-neg. less susceptible than gram - posit.	Porter	1947
Heat on thermophilie bact.	No effect	Arrhenius	1927

TABLE R3 THE EFFECT OF RADIATION ON BACTERIOPHAGE

Factor(s)	Survival	Reference	
ULTRAVIOLET			
E. coli phage			
Uv.	Proportional to its conc.	Fischer	1927
Uv. from alpine sun lamp 1 ft. away of 4.5 amps	Recov. 0, 40 min.	McKinley	1926
Sh. dysenteriae phage			
Uv. 6 or 1.5 erg/sq. mm. per sec. and 2537 A°	Inactivated, larger phage more sensitive	Latarjet	1945
LIGHT			
Micrococcus phage			
Indirect sunlight on 0.01 -0.1% M.B.	5 min.	Clifton	1931
Sunlight 1:100,000 methylene blue	Greatest inactivation	Porter	1947
Virus t_2 phage			
Daylight bulb	Recov. 3%, 70 hr.	Latarjet	1951
ULTRASONIC			
E. coli phage			
Exposed to intense sonic vibration	Inoc. 70%-1 min., Recov. 40%, 30 min.	Anderson	1948
Exposed to intense sonic vibration	Inoc. 100%-1 min., " 1.1%, 60 min.	"	"
OTHER RADIATION			
General phage			
Radium 7-8 microcuries	3 d. contact	Bruynoghe	1925

TABLE 84 THE EFFECT OF RADIATION ON BRUCELLA SPECIES

Factor(s)	Survival	Reference
LIGHT		
B. melitensis		
Tropical sunlight, 44 C.	Inoc. 1 loop 24 h. cult., Recov. 0, 45 min.	Ukil 1927
B. spp.		
Sunlight & dryness	Lower incidence of disease	Polding 1947
ULTRASONIC		
B. melitensis		
2641 kc.	Cell in smooth phase yielded cells in rough phase in 3 h.	Rucci 1949

TABLE R5 THE EFFECT OF RADIATION ON DIPLOCOCCUS PNEUMONIAE

Factor(s)	Survival	Reference	
ULTRAVIOLET			
Uvs	Less susceptible than other org. studied	Wells	1945
LIGHT			
Sunlight	Larger strains more resistant	Soloway	1942
Tropical sunlight, 55C	Inoc. 1 loop 24 hr. cult. Recov. 0, 45 min.	Ukil	1927
Dried sputum, dark	35 d.	Wood	1905
" " light (diffuse)	30 d.	"	"
Moist sputum, strong light	<5 d.	"	"
Dried sputum, sunlight	<4 hr.	"	"
Powdered sputum, dark	4 hr.	"	"
" " sunlight	1 hr.	"	"
Neon light sensitized with methyl violet	Recov. 15 min.	Philibert	1926

TABLE R6 THE EFFECT OF RADIATION ON ESCHERICHIA COLI AND AEROBACTER AEROGENES

Factor(s)	[illegible]	Reference	
ULTRAVIOLET			
E. coli			
Phys. salt soln., ultra-violet lamp (100v, 6-8 amps) dist. of 50cm	More resistant when sensitized with own immune serums	Akiyama	1935
U.v. rays, 15 units	40 sec.	Baker	[illegible]
" at 3500 A°	1 hr	Bayne-Jones	1923
"	Shorter time	Block	[illegible]
" 295-6 mm.	150-300 min.	Browning	1917
Wave lengths 2800, 2650-2700 & 2540 A°	Kills	Bruger	1928
0.01 watt/sq. ft.	Kills 100%, 1 min.	Buttolph	1945
Agar-broth cult., pH 7.4 60 kv.	24 hr.	Cavalli	1940
Wave lengths less than 2800 A°	Lethal effect	Coblentz	1924
U.V. 2510 A°	Killing	Ehrismann	1929
" , 45% R.H.	More lethal than at high humidity	[illegible]	1942
"	Inoc. Innumerable, Recov. 8 3 min	[illegible]	1939
" 24,000 erg/cm²	Kills	"	1944
" 200 erg/mm²	"	Hercik	1936
" 3500-4900 A°	Not given	Hollaender	1943
" without molecular oxygen	Photoreactivation	Johnson	1950
U.v., 200 erg.	Recov. 50%	Latarjet	1943
" rays of 2537 A°	Kills	Lea	1940
" " " " "	Develops resistivity	Luckiesh	1942
"	" "	[illegible]	[illegible]
" dist. of 17 cm	20 min.	Nobele	1928
" in raw water	Inoc. 1500/cc; Recov. Practically 0 10 sec.	Schwarz	1911
" 245 erg/mm² at 2537A°	Reduc. 90%	Sharp	1939
" 24000 erg/cm²	Lethal	"	1940
"	Older strains less resistant than [illegible]	Stenstrom	1951
"	30 min	Tanner	1930
" in broth and air	Recov. 1, 30 min	Wells	1935
" 0.1 watt/sq. ft	Reduc. 99.99%, 10 sec.	"	1940
" on a flowing cylinder of air	Lethal	"	1945
U.v., dry air	Reduc. 99.99%	Whisler	1940
"	Relatively resistant	Witkin	1947
"	The shorter the wave length the more lethal	Wyckoff	1932
Dist. water, full radiation of mercury 10 cm.	5 min.	Bazzoni	1914
Salt water, full radiation of mercury 10 cm. 8mm. deep	" "	"	"
Water, full radiation of iron arc, 8 cm., 2mm. deep	" "	"	"

TABLE R6 (CONT'D) THE EFFECT OF RADIATION ON ESCHERICHIA COLI AND AEROBACTER AEROGENES

Factor(s)	Survival	Reference
ULTRAVIOLET		
A. aerogenes		
U.v.	Destroys the ability to grow on ammonia	Peacocke 1948
LIGHT		
E. coli		
Watery susp'n of fresh cult. placed on petri dishes in sunlight	Inoc. 1 cc., Reduc. 96%, 10-15 min.	Clark 1903
Stored water, sunlight	4-5 wk.	Raghavachari 1939
Diffuse light on polluted water	Inoc. pure cult., death rate was higher in polluted water	Smit 1931
Sunlight 49 C., in urine	Inoc. pure cult., 1 loop 24 h., Recov. 0, 3 h.	Ukil 1927
" 45 C., in feces	Inoc. 1 loop 24 h. cult. Recov. 0, 3 h.	"
Broth and air in dark	Recov. 3/10 sq. ft., 120 min.	Wells 1935
" " " light	Recov. 0, 120 min.	"
X-RAY		
E. coli		
X-ray	Younger die quicker	Cavalli 1948
" 2000,2200 roentgen	37% survival	Fram 1950
Susp'n irradiated with 250 kv. x-rays at 40,000 r/hr.	Only 1/3 sensitivity when oxygen was reduced by saturation with N_2, CO_2, etc.	Hollaender 1951
X-ray	Relatively resistant	Witkin 1947
A. aerogenes		
X-ray 14,000 Roentgens	37% survival	Fram 1950
ULTRASONIC		
E. coli		
Ster. buffer soln., 15.5 C. crystal ultrasonorator used.	Inoc. 6,000;66,000; 628,000 & 6,000,000/ml. Recov. 99%, 40 min.	Horwood 1950
Ultrasonic or standard phosphate buffer	Inoc. $1x10^6$/cc. Reduc. 99.9%, 15 min.	Whitney 1951
OTHER RADIATION		
E. coli		
2300 v. of electrons	Recov. 50%	Dieckmann 1950
10,000 v. in evacuated tube	1 h.	Dognon 1930
Neon light sensitized with methyl violet	No results in 2 hr.	Philibert 1926
Cult. of bouillon with radium	0 multiplication, 48 h.	Bruynoghe 1925

TABLE R7 THE EFFECT OF RADIATION ON MICROCOCCUS SPECIES

Factor(s)	Survival	Reference
ULTRAVIOLET		
M. aureus		
Uv. at 3500A°	1 hr.	Bayne-Jones 1923
"	Shorter time	Brooks 1942
Wave lengths of 2800, 2650, 2700 and 25 40 A°	Kills	Burger 1928
Uv. rays 2000-2950 A°	Reduc. ct.	Cathcart 1942
" " 2660 A°	Bactericidal action	Gates 1929
"	"	Hart 1937-41
" 26000 erg/cm^2	Killed	" 1944
"	"	Laurens 1938
"	Survived	Phelps 1939
" 260 erg/mm^2 at 2537A°	Reduc. 90%	Sharp 1939
" 26000 erg/cm^2	Lethal	" 1940
"	More susceptible than Bacillus veget. and influenza virus	Wells 1945
M. albus		
Uv. at 3500 A°	1 hr.	Bayne-Jones 1923
Wave lengths of 2800,2650 2700 & 2540 A°	Kills	Burger 1928
Uv.	Inoc. innumerable, Recov 2, 3 min.	Hart 1939-40
Uv. 23000 erg/cm^2	Killed	" 1944
Uv. 26200 erg/sq. cm.	1.06 sec.	Sharp 1938
Uv. 23000 erg/cm^2	Lethal	" 1940
Uv. 184 $\mu W/mm^2$ at 2537A°	Reduc. 90%	" 1939
Uv. at $2x10^4$ ergs	Killed	Wells 1931
Uv. at $5x10^6$ " /mm. Hg in vacuum	"	" "
Uv.	More susceptible than Bacillus veget. and influenza virus, Diplococcus, Serratia, S. aureus	" 1945
M. luteus		
Uv.	Not given	Boston 1950
M. citreus		
Wave lengths of 2800,2650, 2700 & 2540A°	Kills	Burger 1928
Uv.	Inoc. 160, Recov. 6, 3 min.	Hart 1939
M. roseus		
Uv.	30 min.	Tanner 1930
M. epidermis		
Uv.	" "	" "
M. spp.		
Uv. 15 units	40 sec.	Baker 1926
Uv.	Reduc. marked, 5 min.	Bedford 1927
Uv. 2380-2940 A° u.	6 min.	Browning 1917
Uv. 410 erg at 2537 A°	Kills	Rivers 1928
Uv.	Older strains less resistant	Stenstrom 1931

TABLE 87 (CONT'D) THE EFFECT OF RADIATION ON MICROCOCCUS SPECIES

Factor(s)	Survival	Reference	
LIGHT			
M. aureus			
Sealed cult. sunlight	657 d.	Lal	1923
Direct sun, 23F	1 hr	Meader	1926
Thru window glass, sun	3 3/4 hr.	"	"
Sun thru thin window glass	2 3/4 hr.	"	"
Sunlight, 43C	Inoc. 1 loop 24 hr. cult. Recov. 0, 2 hr.	Ukil	1927
M. spp.			
Dark, 55C	Inoc. 124, Recov. 41, 40 min.	Buchbinder	1941
" 50C	Inoc. 62, Recov. 60, 30 min.	"	"
" 45C	Inoc. 187, " 71, 80 min.	"	"
" 40C	Inoc. 139, " 100, 60 min.	"	"
Hydrogen peroxide, sun	No growth	Burnet	1925
July sun	12 hr.	Duclaux	1887
X-RAY			
M. aureus			
X-ray 3600-4400	37% survival	Fram	1950
ULTRASONIC			
M. aureus			
Ringer soln., ultrasound frequency 320 kilocycle	Inoc. 40.2×10^9, Reduc. 90.4%, 45 min.	Grabar	1945
OTHER RADIATION			
M. albus			
Low velocity electrons	Killed	Wells	1931
M. spp.			
10,000 v. in evacuated tube	1 hr.	Dognon	1930
Neon light sensitized with methyl violet	Recov. 0, 1 min.	Philibert	1926

TABLE R8 THE EFFECT OF RADIATION ON MICROORGANISMS

Factor (s)	Survival	Reference
ULTRAVIOLET		
<u>Alcaligenes melitensis</u>		
Uv. 15 units	40 sec.	Baker 1926
<u>Alcaligenes sp.</u>		
Uv. 15 units	30 min.	Tanner 1930
<u>Corynebacterium diphtheriae</u>		
Uv. on agar	Reduc. marked, 5 min.	Bedford 1927
Uv. 337 erg/mm² at 2537 A°	Reduc. 90%	Sharp 1939
Uv.	More susceptible than Bacillus, Serratia, Staph, Diplococcus, influenza virus	Wells [illegible]
<u>Corynebacterium pseudodiphtheriticum</u>		
Uv. on agar	Reduc. slight, 5 min.	Bedford 1927
<u>Hemophilus influenzae</u>		
Uv.	Shorter time	Brooks 1942
<u>Klebsiella pneumoniae</u>		
Uv.	Inoc. innumerable, Recov 19, 3 min.	Hart 1939
<u>Lactobacillus acidophilus</u>		
Uv.	Reduced	Du Buy 1948
<u>Proteus vulgaris</u>		
Uv.	Inoc. innumerable, Recov 2, 3 min.	Hart 1939
Uv.	Older strains less resistant	Stenstrom 1931
<u>Serratia marcescens</u>		
Uv.	Germicidal effect	Bachem 1933
Uv. 15 units	40 sec.	Baker 1926
Uv. presence of dyes	Not given	Boston 1950
Uv. 2810 A°	Kills	Ehrismann 1929
Uv. 20,000 erg/cm²	"	Hart 1944
Uv. 2537 A°	"	Lea 1940
Uv. distance of 17 cm.	5 min.	Nobele 1928
Uv., air	Kills (more effective when air is moving)	Robertson 1939
Uv., air	15 min.	Rosenstern 1942
Uv. in raw water	Inoc. 250,000/cc, Recov. 15/cc, 15 sec.	Schwarz 1911
Uv. 220 erg/mm² at 2537 A°	Reduc. 90%	Sharp [illegible]
Uv. 20,000 erg/cm²	Lethal	" 1940
Uv. 135 cm. away	Recov. 0, 25 min.	Strebel 1901
Uv.	More susceptible than Bacillus, Staph., Dilococcus, influenza virus	Wells 1945
LIGHT		
<u>Azotobacter sp.</u>		
Soil in sun	Destroys	Dhar 1939
<u>Corynebacterium diphtheriae</u>		
Neon light sensitized with methyl violet	Recov. 0, 5 min.	Philibert 1926

TABLE R8 (CONT'D) THE EFFECT OF RADIATION ON MICROORGANISMS

Factor(s)	Survival	Reference
LIGHT (cont'd)		
Corynebacterium diphtheriae		
Pure cult. swabs in dark	60 d.	Schofield 1916
" " " light	30 d.	"
Tropical sunlight, 55 C.	Inoc. 1 loop 24 hr. cult. Recov. 0, 45 min.	Ukil 1927
Corynebacterium spp.		
Drying in dark	6 wk.	Ottosen 1945
" daylight	4 wk.	"
Leptospira icterohemorrhagica		
Light, R.T.	7 d.	T & W. 1940
Pasteurella pestis		
Tropical sunlight, 40 C.	Inoc. 1 loop 24 hr. cult., Recov. 0, 5 min.	Ukil 1927
Proteus spp.		
Neon light	Not destroyed after 30 min.	Philibert 1926
Treponema pallidum		
On cloth, 21.5-25 C., diffuse light	11½ h.	Zinsser 1914
X-RAY		
Serratia marcescens		
X-ray 1200-1300 roentgens	37% survival	Fram 1950
OTHER RADIATION		
Proteus vulgaris		
10,000 v. in evacuated tube	Not destroyed after 30 min.	Philibert 1926
Serratia marcescens		
10,000 v. in evacuated tube.	1 h.	Dognon 1930

TABLE R4 THE EFFECT OF RADIATION ON MYCOBACTERIUM TUBERCULOSIS

Factor(s)	Survival	Reference	
ULTRAVIOLET			
Saline, uv. 7620-2300 A°	Inoc. [illegible] of susp'n, Recov. 0, 10 min.	Eidenow	1927
Saline, uv. 5720-2800 A°	Inoc. 15 ccm. of susp'n, Recov. 0, 30 min.	"	"
Uv.	Death slower at low temp than high, pH has no effect	Howze	1926
Guinea pigs injected with 5cc urine, uv.	20-40 min.	Nasta	1930
Uv.	More resistant	Wells	1941
"	Less susceptible than Bacillus spores	"	1945
Quartz-Hg vapor at 5in. from a 300 hr. burner	3 min.	Meyer	1924
Quartz-Hg vapor as above plus quinine	25 min.	"	"
LIGHT			
Mixed sputum in sunlight	Inoc. into guinea pigs, 2-72 hr.	Caldwell	1925
Sunlight	Inhibit development	De Carvalho	1933
Diffuse daylight	5-7 d.	Koch	
Sunlight	< 2 hr.	"	1890
"	<5 "	Laurens	1938
Direct sunlight	Destroys	Mayer	1921
Sputum in sunlight	Few min.-48 hr.	"	1924
" on cover slips in dark, 70F, R.H. 83%	Inoc. 1075000, 142 d.	Smith	1942
Sputum on blank table in water susp'n 63F, R.H. 77%, dark	Inoc. 0 1mg/cc, 15 d.	"	"
Sputum, 72F, R.H. 79%, dark	Inoc. 575000, 18 d.	"	"
Sputum in direct India sun	6-8 d.	Soparkar	1917
Electrical light	(Bovine) 74-100 d.	"	"
Sputum, dark	309 d.	"	"
Direct sunlight sputum from lung of deer	10-12 hr. (Bovine)	"	"
Diffuse light, sputum from lung of deer	(Bovine) 30 d.	"	"
Diffuse light, " " lung	6-8 d.	"	"
Sunlight, 530	Inoc. 1 loop 24 hr. cult. Recov. 0, 30 min.	Ukil	1927
"	Recov. 0, 20 min.	Weinzirl	1907
X-RAY			
X-ray on agar	64 hr.	Minck	1896
ULTRASONIC			
Saline, ultrasound frequency 320 kilocycles	Inoc. $3.8x10^9$, Reduc. 75%, 75 min.	Grabar	1945

TABLE R10 THE EFFECT OF RADIATION ON NEISSERIA SPECIES

Factor(s)	Survival	Reference
ULTRAVIOLET		
N. catarrhalis		
Wave lengths of 2800, 2650, 2700, & 2540 A°	Kills	Burger 1928
LIGHT		
N. meningitidis		
24 h. cult., direct sunlight, 10AM-6PM, 35-37 C.	2 h.	Beltencourt 1904
24 h. cult. direct sun 12 noon-evening	"	"
24 h. cult., immersed in water bath; 50 C.	3 min.	"
55 C.	1 min.	"
60, 70, 80 C.	1 min.	"
100 C.	30 sec.	"
24 h. bouillon cult. 0-7 C.	>1 mo.	"
Direct sunlight, dried in films on surface of glass, wood, cotton	Few hrs.	Miller 1944
Diffuse daylight passing 2 layers of gauze	30 h.	"
Diffuse daylight thru cotton towelling & wood	6-7 d.	"
Glass beads, R.T., dark	10 d.	"
Wood " " "	8 d.	"
Cotton " " "	7 d.	"

TABLE R11 THE EFFECT OF RADIATION ON PROTOZOA AND METAZOA

Factor(s)	Survival	Reference
ULTRAVIOLET		
Amoebae		
Short exposure to uv.	Killed	Chamberlain
Paramecium		
Uv.	Killed	Tang, 1937
LIGHT		
Necator americanus		
Outdoors dense shade, incubated 6-7 d.	7-9 wk.	Augustine 1923
Outdoors moderate shade	5½ wk.	" "
Direct sun	1 wk.	" "
Water covered soil, dense shade	Reduc. 99%, 10 d.	" "
Water covered soil, dense shade	Recov. 0, <4 wk.	" "
Water covered soil, light shade	Reduc. 99%, 18 d.	" "
Water covered " " shade	Recov. 0, <4 wk.	" "
Water covered " direct sun	" " 1 wk.	" "
Tap water, direct sun	" " " "	" "
" " moderate shade	" " 15 d.	" "
" " dense shade	Reduc. 96%, 20 d.	" "
" " " "	Reduc. 45%, 1½ mo.	" "
Alternating moist and drying soil	Recov. 0, 8 wk.	" "
Drying soil, dense shade	" " >1 mo.	" "
" " moderate "	" " 10 d.	" "
" " direct sun	" " 5 d.	" "
Feces, strong sun	>2 hr.	Nicoll 1917

TABLE R12) THE EFFECT OF RADIATION ON PSEUDOMONAS SPECIES

Factor(s)	Survival	Reference	
ULTRAVIOLET			
P. aeruginosa			
Full radiation of Hg arc at 8cm. on agar cult.	15 min.	Bazzoni	1914
In water, full radiation of Hg arc, 8cm.	Recov. 0, 3 min.	"	"
In water, full radiation of iron arc, 8 cm.	" " " "	"	"
Uv.	Inoc. innumerable, Recov. 38, 3 min.	Hart	1939
Uv. 16000 erg/cm^2	Kills	"	1944
Uv.	Survived	Phelps	1939
Dosages of uv. which are ordinary lethal	"	Sharp	1940
Uv. 16000 erg/cm^2	Lethal	"	"
P. fluorescens			
Uv.	Not given	Boston	1950
Uv.	More resistant than non-fluorescens, convert short wave lengths into long	Burge	1915
P. sp.			
Uv.	Shorter time	Brooks	1942
LIGHT			
P. aeruginosa			
Tropical sunlight, 44C	Inoc. 1 loop 24 hr. cult. Recov. 0, 1½ hr.	Ukil	1927
Neon light	Not destroyed after 30 min.	Philibert	1926
X-RAY			
P. aeruginosa			
X-ray 1000-1200 roentgens	37% survival	Fram	1950
P. fluorescens			
X-ray 1000-1100 "	" "	"	"
OTHER RADIATION			
P. aeruginosa			
Cult. of bouillon, radium	0 multiplication, 48 hr.	Bruynoghe	1925

TABLE R13 THE EFFECT OF RADIATION ON SALMONELLA SPECIES

Factor(s)	Survival	Reference
ULTRAVIOLET		
<u>S. typhosa</u>		
Phys. salt soln., Uv. at distance of 50 cm. (lamp 100 v., 6-8 amps)	More resistant when sensitized with own immune serums	Akiyama 1935
Uv. rays, 15 units	40 sec.	Baker 1926
Agar, full radiation of Hg arc, 10 cm.	Recov. plus, 10 min.	Bazzoni 1914
Normal salt, full radiation of Hg arc, 5 cm.	Recov. 0, 30 sec.	"
Uv. on agar	Reduc. very slightly, 5 min.	Bedford 1927
Fluid, pH 2, Uv.	2 sec.	Browning 1917
Wave lengths of 2800, 2650 2700 & 2540 Å	Kills	Burger 1928
Uv.	Inoc. 200 cc. emulsion, Recov. 0, 5 min.	Gilles 1935
Uv. 2100-2800 Å	Very sensitive	Newcomer 1917
Fe sparks, 1990-2005 Å	Recov. 4100, 10 min.	"
" " 2250-2270 "	" 6500, "	"
" " 2485-2510 "	" 0 "	"
" " 2645-2675 "	" 100 "	"
" " 2845-2385 "	" 700 "	"
" " 2945-2985	" 4500 "	"
Uv. 214 erg/mm² at 2537 Å	Reduc. 90%	Sharp 1939
Cu sparks, 2130-2140 Å	Recov. 5722, 10 min.	Newcomer 1917
" " 2205-2225 "	" 30 "	"
" " 1990-2105 "	" 1 "	"
<u>S. paratyphi A & B</u>		
Uv. ray, 15 units	40 sec.	Baker 1926
<u>S. enteritidis</u>		
Uv. rays 2000-2950 Å	Reduced count.	Cathcart 1942
<u>S. typhimurium</u>		
Uv.	The shorter the wave the more lethal	Wyckoff 1932
LIGHT		
<u>S. typhosa</u>		
Thin layer of water, sun	1 h.	Clark 1902
Water in bottles	5 h.	"
Watery susp'n of fresh cult. placed on petri dishes, sunlight	Inoc. 1 cc., Reduc. 95% 10-15 min.	"
Sealed cult. in dark	2906 d.	Lal 1923
" " in direct sun	60 d.	"
Sealed cult. in sunlight & diffuse light	365 d.	"
Sealed cult., diffuse	"	"
" " 37 C., dark	"	"
" " R.T. "	"	"
Beef peptone agar in direct sun	Recov. 0, 10-60 min.	[illegible] 1936
Beef peptone agar in diffuse light	" " 5-7 h.	"

TABLE R13 (CONT'D) THE EFFECT OF RADIATION ON SALMONELLA SPECIES

Factor(s)	Survival	Reference	
LIGHT (Cont'd).			
S. typhosa			
Direct rays of sun	4-10 h.	Osler	1901
Sunlight, 40 C.	Inoc. 1 loop 24 hr. cult. Recov. 0, 20 min.	Ukil	1927
Neon light	Not destroyed after 30 min.	Philibert	1926
S. paratyphi A			
Sunlight, 42 C.	Inoc. 1 loop of 24 hr. cult., Recov. 0, 30 min.	Ukil	1927
S. paratyphi B			
Sunlight, 48 C.	Inoc. 1 loop 24 hr. cult. Recov. 0, 1 h.	"	
Neon light	Not destroyed after 30 min.	Philibert	1926
S. enteritidis			
Tropical sunlight, 49 C.	Inoc. 1 loop 24 hr. cult. Recov. 0, 3 h.	Ukil	1927
X-RAY			
S. typhosa			
Bouillon cult., 40 C.	Inoc. 1 loop, Recov. no difference in #, 3 h.	Minck	1896
OTHER RADIATION			
S. typhosa			
Irradiation	0 multiplication	Bruynoghe	1925
10,000 v. in evacuated tube	1 h.	Dognon	1930
S. paratyphi A & B			
10,000 v. in evacuated tube	1 h.	"	
S. typhosa			
Cult. of bouillon, radium	0 multiplication, 48 h.	Bruynoghe	1925

TABLE R14 THE EFFECT OF RADIATION ON SHIGELLA SPECIES

Factor(s)	Survival	Reference	
ULTRAVIOLET			
<u>S. dysenteriae</u>			
Wave lengths 2800, 2650, 2700 & 2540 A°	Kills	Burger	1928
<u>S. paradysenteriae</u>			
Uv. 168 erg/mm² at 2537 A°	Reduc. 90%	Sharp	1939
LIGHT			
<u>S. dysenteriae</u>			
Strong sunlight, cultured in bouillon	< 30 min.	Bamberger	1936
Sealed cult. sunlight	920 d.	Lal	1923
" " direct sunlight & diffuse light	75 d.	"	
Sealed cult., diffuse light	365 d.	"	
" " 37 C., dark	"	"	
" " R.T. "	"	"	
Sunlight, 44 C.	Inoc. 1 loop 24 hr. cult. Recov. 0, 2 min.	Ukil	1927
<u>S. paradysenteriae (Flexner)</u>			
Strong sunlight, cultured in bouillon	< 60 min.	Bamberger	1936
Sealed cult., sunlight	1045 d.	Lal	1923
" " direct sun, and diffuse light	100 d.	"	
Sealed cult. diffuse light	365 d.	"	
" " 37 c., dark	"	"	
" " R.T. "	"	"	
Sunlight on feces	1 h.	Stewart	1944
<u>S. paradysenteriae (Sonne)</u>			
Strong sunlight, cultured in bouillon	< 30 min.	Bamberger	1936
<u>S. ambigua</u>			
Strong sunlight, cultured in bouillon	< 40 min.	"	
ULTRASONIC			
<u>S. dysenteriae</u>			
Isotonic PO_4, pH 7.3, ultrasound frequency 680 kilocycles	Inoc. 120.8×10^8, Reduc. 88%, 30 min.	Gruber	1945
<u>S. paradysenteriae</u>			
Ringer liquid, ultrasound 320 kilocycles	Inoc. 6.2×10^8, Reduc. 98%, 30 min.	"	
OTHER RADIATION			
<u>S. dysenteriae</u>			
Neon light	Not destroyed after 30 min.	Philibert	1926

TABLE R25 THE EFFECT OF RADIATION ON STREPTOCOCCUS SPECIES

Factor(s)	Survival	Reference
ULTRAVIOLET		
S. pyogenes		
Uv.	Shortened time	Brooks 1942
"	Inoc. innumerable, Recov. 12, 3 min.	Hart 1939
Uv. 216 erg/mm^2 at 2537 Å.	Reduc. 90%	Sharp 1939
S. viridans		
Uv.	Less susceptible than Bacillus spores and t.b.	Wells 1945
S. hemolyticus		
Uv.	Less susceptible than Bacillus spores, t.b., & S. viridans	"
S. salivarius		
Uv. 200 erg/mm^2 at 2537 Å	Reduc. 90%	Sharp 1939
S. spp.		
Phys. salt soln., Uv. lamp (100 v., 6-8 amps) at distance of 30 cm.	More resistant when sensitised with immune serum	Akiyama 1935
Uv.	1946-44.4% present, 1949-81.9%	Wilcroeas 1950
Uv., 1 cu. ft. of air	Recov. 0	Henle 1942
Uv. irradiation of upper air	Kills	Jarrett 1948
LIGHT		
S. pyogenes		
Sunlight	Recov. 50%, 40 min.	Buchbinder 1941
Daylight	6 hr.	"
" , R.T.	42-252 min.	"
Dark, and R.T.	12-132 h.	"
On floor in petri dishes in dark	Recov. 20%, 14 d.	Phelps 1939
On floor in petri dishes in diffuse light	" <1%, <7 d.	"
S. spp.		
Visible light	Kills	Buchbinder 1941
Sunlight	Recov. 50%, 5 min.	"
"	Larger strains more resistant to daylight	Solomon 1942
Tropical sunlight on glass 49 C.	Inoc. 1 loop 24 h. cult. Recov. 0, 15 min.	Uhil 1927
Sputum, tropical sunlight 50 C.	Inoc. 1 loop 24 h. cult. Recov. 0, 30 min.	"
Neon light sensitized, methyl violet	Recov. 0, 30 min.	Philibert 1926
OTHER RADIATION		
S. faecalis		
10,000 v, in evacuated tube.	1 h.	Dognon 1930

TABLE R16 THE EFFECT OF RADIATION ON VIBRIO CHOLERAE

Factor(s)	Survival	Reference	
ULTRAVIOLET			
Uv.	Reduc. complete, 5 min.	Bedford	1927
Uv. in raw water	Inoc. 1500/cc, Recov. practically 0, 15 sec.	Schwarz	1911
LIGHT			
Sealed cult.	1044 d.	Lal	1923
" " direct sunlight & diffuse light	3 d.	"	"
Sealed cult. diffuse light	279 d.	"	"
" " 37C, dark	71 d.	"	"
" " RT "	365 d.	"	"
Sea water direct sunlight	8 hr.	Matsuda	1910
Tropical sunlight, 49C	Inoc. 1 loop 24 hr. cult Recov. 0, 15 min.	Ukil	1927
Sunlight 30-18C	Inoc. 300,000 in 1cc water, Reduc. 99.9%, 5 hr.	Yasukawa	1933
Exposed polarized light, 24C	Inoc 1 in 100,000 dil'n, Recov. 121 colonies, 13-30 hr.	Lal	1926
OTHER RADIATION			
Cult. of bouillon, radium	0 multiplication, 48 hr.	Bruynoghe	1925

TABLE R17 THE EFFECT OF RADIATION ON VIRUSES

Factor(s)	Survival	Reference
ULTRAVIOLET		
Polio virus		
Uv.	> destruction than sun	Carlson 1942
Uv.	Inactivated	Dick 1951
Uv., < 38.5 C., 2800-3100 Å	30 min.-1 min.	Jungleblut 1937
Uv.	Recov. plus up to 2 h.	Levaditi 1942
Uv. at 8 in.	Inoc. 6cc of 1% susp'n., 75 min. (did not infect animals)	Toomey 1937
Influenza virus		
Uv.	Not given	Hollaender 1944
"	More resistant than E. coli	"
"	Killed	Wells 1936
"	Sensitive	" 1941
"	More susceptible than Bacillus veget.	" 1945
Vaccine virus		
Short wave Uv.	40 min.	Barkad 1932
Uv. 480 ergs at 2537 Å	Kills	Rivers 1928
Herpes virus		
Cornea, Uv.	< 15 min.	Gundersen
Fresh normal rabbit serum and Uv.	10 min.	"
Uv.	Recov. 0, 30 min.	Levaditi 1942
Uv. from alpine sun lamp 1 ft. away of 4.5 amps.	Recov. 0, 40 min.	McKinley 1926
Encephalomyelitis virus		
Uv. from alpine sun lamp 1 ft. away of 4.5 amps.	" "	"
Uv.	Not given	Taylor 1941
Tobacco mosaic virus		
Uv. 3100-2652 Å	Inactivation	Duggar 1934
African horse-sickness virus	"	
Uv.	"	Polson 1950
Measles, chicken-pox, mumps		
Uv.	Sensitive	Wells 1941
Virus general		
Uv. 2537 Å.	Sensitivity similar to bacteria	Hollaender 1943
Uv.	Correlation between inactivation dose & size	Lea 1947
LIGHT		
Polio virus		
Direct sunlight	30 min.	Carlson 1942
Sunlight	Rapidly killed	Flexner 1916
Vaccinia virus		
Thiazine, acridine & thioxanthine dyes & light energy	< 5 min.	Herzberg 1933
Foot & mouth virus		
Dried & exposed to noon August sun.	1 h.	Bedson 1927

TABLE R17 (CONT'D) THE EFFECT OF RADIATION ON VIRUSES

Factor(s)	Survival	Reference
LIGHT (cont'd)		
Foot & mouth virus		
Dried & exposed to winter light	> 1 h.	Bedson 1927
ULTRASONIC		
Polio virus		
Sonic vibration	Not affected	Scherp 1936
OTHER RADIATION		
Polio virus		
High speed electrons	Inactivated	Dick 1951

TABLE B18 THE EFFECT OF RADIATION ON YEASTS, MOLDS, & FUNGI

Factor(s)	Survival	Reference
ULTRAVIOLET		
Yeasts		
Uv., 24 C., high humidity	Recov. 0, 5 min.	Beauverie 1934
" light, 1200 candle power lamp at 20 cm.	7 min.	De Fazi 1921
Uv.	Recov. 0, 5 min. expos.	Giller 1935
"	Inoc. 32,000; Reduc. 99%	Schnegg 1936
"	Not given	Sterckx 1935
"	Effect may result from absorption of energy	Oster 1935
Molds		
Uv. in air	Kills	Luchiesh 1949
"	Older org. less resist.	Stenstrom 1931
"	Dark colored molds more resistant	Sutton 1941
Uv. on cardboard strips	Not entirely killed	Tanner 1941
Fungi		
Uv.	Lethal action, pigmentation is a defense	Chavarria 1924
" 2650 Å	Increased resistance with age	Dimond 1941
Uv. in petri dishes at 25 cm.	1-10 min.	Fever 1920
Uv.	Inoc. innumerable, Recov. 0, 20 min.	Hart 1939
Uv. 3,[illegible]00 Å	Kills	Hollaender 1943
LIGHT		
Fungi		
Sunlight	Not given	Ward 1894
"	8 h.	Weinzirl 1914
ULTRASONIC		
Yeasts		
Ringer soln., ultrasound frequency 680 Kilocycle	Inoc. 1.3×10^9, Reduc. 85%, 30 min.	Grabar 1945
OTHER RADIATION		
Molds		
Electron bombardment in high vacuum	Survive	Cooper 1936
10,000 V. in evacuated tube	1 h.	Dognon 1930

References (Radiation)

1. Akiyama, M. 1935 Resistance of bacteria to ultraviolet rays. Sei-i-kai Med. J., 54, 840-855.
2. Arloing, S. 1885 Influence de la lumiere sur la vegetation et les proprietes pathogenes du *Bacillus anthracis*. Compt. rend. acad. sci., 100, 378-381.
3. Arloing, S. 1886 Influence de la lumiere blanche et de ses rayons, constituants sur le developpement et les proprietes du *Bacillus anthracis*. Arch. Physiol. Norm. et Path., Ser. 3, 7, 209-235.
4. Arloing, S. 1887 Compt. rend., 104, 701-703.
5. Arrhenius, S. 1927 Die thermophilen Bakterien und der Strahlungsdruck der Sonne. Z. Phys. Chemie., 130, 516-519.
6. Augustine, D.L. 1923 Experiments on the factors determining the length of life of infective hookworm larvae. Am. J. Hyg., 3, 420-443.
7. Bachem, A., and Dushkin, M.A. 1933 Time factors concerned in the germicidal action of ultraviolet light. Proc. Soc. Exp. Biol. Med., 30, 700-704.
8. Baker, S.L., and Nanavutty, S.H. 1929 A quantitative study of the effect of ultraviolet rays upon the bacteriophage. I. A comparison between the lethal effects of ultraviolet rays upon the bacteriophage, *B. coli* and some enzymes and antibodies. Brit. J. Exp. Path., 10, 45-61.
9. Baker, S.L., and Peacock, P.R. 1926 The susceptibility of the infective agent of the Rous chicken-sarcoma to the action of ultraviolet rays. Brit. J. Exp. Path., 7, 310-316.
10. Bamberger, A. 1936 Resistance of dysentery and pseudodysentery bacilli to external influences. Zentr. Bakt. Abt. I, 137, 142-151.
11. Barkad, A., Benard, H., and Camus, L. 1932 Effect of short wave (u-v) radiation on vaccinal virus and its adventitious bacteria. Compt. rend. soc. biol., 110, 1278-1280.
12. Bayne-Jones, S., and Van der Lingen, J.S. 1923 The bactericidal action of ultraviolet light. Bull. Johns Hopkins Hosp., 34, 11-16.
13. Bazzoni, C.B. 1914 The destruction of bacteria through the action of light. Am. J. Pub. Health, 4, 975-992.
14. Bean, N.I. 1903 J. Adv. Therapy, New York, 21, 362.
15. Beauverie, J. 1934 Individual resistance of microorganisms to ultraviolet radiations. Compt. rend. acad. sci., 198, 2017-2019.
16. Beckwith, T.D., and Weaver, C.E. 1936 Sonic energy as a lethal agent for yeast and bacteria. J. Bact., 32, 361-373.
17. Bedford, T.H.B. 1927 Nature of action of ultraviolet light on microorganisms. Brit. J. Exp. Path., 8, 437-441.
18. Bedson, S.P., Maitland, H.B., and Burbury, Y. 1927 "2nd Progress Report, Foot and Mouth Disease Committee, Ministry of Agriculture, London.
19. Beltencourt, A., and Franca, C. 1904 Ueber die Meningitis cerebrospinalis epidemice und ihren specifischen Erreger. Z. Hyg. Infektionskrankh., 46, 463-516.
20. Boston University Optical Research Laboratory 1950 The effect of ultraviolet light on *Serratia marcescens*, *Micrococcus luteus* and *Pseudomonas fluorescens* in the presence of certain dyes- photodynamic action. Technical Note No. 67.

21. Brooks, G.L., Wilson, V., and Blackfen, K.D. 1942 Studies of cross-infection in infant's hospital in Boston. Aerobiology Am. Assoc. Adv. Sc., No. 7, 228-236.
22. Browning, C.H., and Russ, S. 1917 The germicidal action of ultraviolet radiation, and its correlation with selective absorption. Proc. Roy. Soc. London, Series B., 90, 33.
23. Bruynoghe, R., and Mund, W. 1925 Action of radium on microbes. Compt. rend. soc. biol., 92, 211-212.
24. Bruynoghe, R., and Mund, W. 1925 Irradiated microbes and bacteriophage. Compt. rend. soc. biol., 92, 464-465.
25. Buchbinder, L. 1942 The transmission of certain infections of respiratory origin. A critical review. J. Am. Med. Assoc., 118, 718-730.
26. Buchbinder, L., Solowey, M., and Phelps, E.B. 1941 The survival rates of streptococci exposed to natural (daylight and sunlight) and artificial light in simulated room environments. J. Bact., 42, 79.
27. Buchbinder, L., Solowey, M., and Phelps, E.B. 1941 Survival rates of streptococci in the presence of natural daylight and sunlight and artificial illumination. J. Bact., 42, 353.
28. Bujwid, O. The action of ultraviolet rays upon bacteria. J. Gasbel., 54, 853-863.
29. Burge, W.E., and Neill, A.J. 1915 The comparative rate at which fluorescent and non-fluorescent bacteria are killed by exposure to ultraviolet. Am. J. Physiol., 38, 399.
30. Burger, G.N. 1928 Critical wave-lengths in killing bacteria. Bull. Basic Sci. Res., 2, 46-54.
31. Buttolph, L.J. 1944 Physical basis of air disinfection by ultraviolet energy. Arch. Phys. Therapy, 25, 671-682.
32. Buttolph, L.J. 1945 Principles of ultraviolet disinfection of enclosed spaces. Heat. Pip. and Air Cond. (ASHVE Jour. Sect.), 17, 282.
33. Caldwell, M.E. 1925 Viability of Mycobacterium tuberculosis in a semi-arid environment. J. Infectious Diseases, 37, 465-472.
34. Cambier, M.R. 1929 Bull. Acad. Med., 102, 13.
35. Carlson, H.J., Ridenour, G.M., and McKhann, C.F. 1942 Efficacy of standard purification methods in removing poliomyelitis virus from water. Am. J. Pub. Health, 32, 1256-1262.
36. Cathcart, W.H., Ryberg, R.E., and Merz, A. 1942 Staphylococci and Salmonella control in foods; effect of ultraviolet radiation and ozone on bakery custard and cream fillings. Food Research, 7, 1-9.
37. Cavalli, L.L., and Modrone, Niccolo Visconti di 1948 Variations in resistance to mutagenic agents in Escherichia coli. I. X-rays and ultraviolet. Ricerca Sci., 18, 785-789.
38. Cernovodeanu, Mlle, and Henri, V. Action of ultraviolet rays upon microorganisms and various cells. Microchemical study. Compt. ren., 150, 729-731.
39. Chamberlain, W.P., and Vedder, E.B. The effect of ultraviolet rays on amoebae, and the use of these radiations in the sterilization of water. Philippine J. Sci., 6, 383-394.
40. Chavarria, A.P., and Clark, J.H. 1924 Reaction of pathogenic fungi to ultraviolet light. Role played by pigment in this reaction. Am. J. Hyg., 4, 639-649.

41. Clark, H.W., and Gage, S. de M. 1902 Annual Report Mass. State Bd. Health.
42. Clark, H.W., and Gage, S. de M. 1903 34th Ann. Report, State Board of Health, Mass.
43. Clement, E. 1886 De la lumiere; de son role hygienique; de son ultilization dans les villes. Lyon Med.
44. Clifton, C.E. 1931 Photodynamic action of certain dyes on the inactivation of staphylococcus bacteriophage. Proc. Soc. Exp. Biol. Med., 28, 745-746.
45. Coblentz, W.W., and Fulton, H.R. 1924 A radiometric investigation of the germicidal action of ultraviolet radiation. Sci. Papers, Bureau Standards, No. 495.
46. Cooper, F.S. 1936 Biological effect of slow electrons. Ph.D. Thesis, Dept. of Physics, M.I.T.
47. Curran, H.R., and Evans, F.R. 1938 Sensitizing bacterial spores to heat by exposing them to ultraviolet light. J. Bact., 36, 455-465.
48. De Carvalho, A., and Moniz Pereira, J. 1933 Effect of sunlight on growth of tubercle bacilli. Compt. rend. soc. biol., 113, 526-528.
49. De Fazi, R. 1921 The action of ultraviolet rays on the Saccharomycetes. J. Ind. Eng. Chem., 13, 265.
50. De Larequette, M. 1918 Bactericidal action of sunlight. Total white light or colored light. Ann. Inst. Pasteur, 32, 170-192.
51. Dhar, N.R., and Seshacharyulu, E.V. 1939 New aspects of nitrogen fixation and conservation in the soil. III. Influence of light on bacterial numbers and nitrogen fixation. J. Indian Chem. Soc., 16, 463-476.
52. Dieckmann, C., and Dittrich, W. 1950 Die Toetung von Coli-Bakterien durch schnelle Elektronen eines 6 MeV- Betatrons. Strahlentherapie, 81, 215-222.
53. Dimond, A., and Duggar, B.M. 1941 Some lethal effects of ultraviolet radiation on fungus spores. Proc. Natl. Acad. Sci., 27, 459-468.
54. Dognon, A. 1930 Resistance of bacteria to low air pressure; possibilities of biological study of slightly penetrating rays. Compt. rend. soc. biol., 103, 886-887.
55. Downes, A., and Blunt, T.P. 1877 Researches on the effect of light upon bacteria and other organisms. Proc. Roy. Soc., 26, 488-500.
56. Downes, A., and Blunt, T.P. 1878 Proc. Roy. Soc., 28, 199.
57. Du Buy, H.G.; Et Al 1948 Evaluation of ultraviolet radiation of sleeping quarters as supplement of accepted methods of disease control. Am. J. Hyg., 48, 207-226.
58. Duclaux, E. 1887 Action de la lumiere sur les microbes. Revue critique. Ann. Inst. Pasteur, 1, 88-92.
59. Duggar, B.M., and Hollaender, A. 1934 Irradiation of plant viruses and of microorganisms with monochromatic light. I and II. J. Bact., 27, 219-239, 241-256.
60. Duggar, B.M., and Hollaender, A. 1936 Inactivation of the virus of typical tobacco mosaic and of E. coli in the shorter ultraviolet. J. Bact., 31, 52.
61. Ehrismann, O. 1929 Bactericidal action of ultraviolet light from various sources; comparative study. Z. Hyg. Infektionskrankh., 110, 746-754.

62. Eidenow, A. 1927 Bactericidal action of ultraviolet rays on tubercle bacilli. Brit. Med. J., 2, 160-161.
63. Elford, W.J., and Van den Ende, J. 1942 An investigation of the merits of ozone as an aerial disinfectant. J. Hyg., 42, 240-265.
64. Emmerson, H. 1933 Sunlight and health. Am. J. Pub. Health, 23, 437-440.
65. Fever, B., and Tanner, F.W. 1920 The action of ultraviolet on the yeast-like fungi. J. Ind. Eng. Chem., 12, 740-741.
66. Fischer, R., and McKinley, E.B. 1927 The resistance of different concentrations of a bacteriophage to ultraviolet rays. J. Infectious Diseases, 40, 399.
67. Flexner, S. 1916 Rockefeller Institute Pamphlet.
68. Fram, H., Proctor, B.E., and Dunn, C.G. 1950 Effects of X-rays produced at 50 kilovolts on different species of bacteria. J. Bact., 60, 263-267.
69. Gärtner, K. 1947 Zur unterschiedlichen Wirkung ultravioletter Strahlen auf grampositive undgramnegative Bakterien. Z. Hyg. Infektionskrankh., 127, 273-279.
70. Gastaldi, C., and Cafferatti, E. 1949 Sensitivity of some bacteria to soft roentgen radiations. Giorn. Batteriol. e Immunol., 41, 218-227.
71. Gates, F.L. 1929 A study of the bactericidal action of ultraviolet light. J. Gen. Physiol., 13, 231, 249.
72. Giese, A.C. 1945 Physiol. Zool., 18, 223-250.
73. Gilcreas, F.W., and Roberts, H.V. 1950 Bacteriologic studies in disinfection of air in large rural central schools. I. Ultraviolet irradiation. Am. J. Pub. Health, 40, 808-812.
74. Gilles, E. 1935 Bacilli sterilized by means of high tension lamp which emits ultraviolet rays. Compt. rend. soc. biol., 118, 1440-1442.
75. Grabar, P., and Rouyer, M. 1945 Disintegration of bacteria by ultrasounds. Ann. Inst. Pasteur, 71, 154-157.
76. Graham-Smith, G.S. 1930 Longevity of dry spores of anthrax bacilli. J. Hyg., 30, 213-215.
77. Grancher, N.I., and Richard, N.I. 1889 Action du sol sur les microbes pathogenes. Rev. Scient., Paris, 44, 365-369.
78. Harris, F.I., and Hoyt, H.S. 1919 Action of ultraviolet light on certain bacteria in relation to specific absorption by amino acids. University of California Pub. Pathology, 2, 245-250.
79. Hart, D. 1938 Sterilization of air in operating room with bactericidal radiation. Comparative analysis of 132 individual stages of extrapleural thoracoplasties performed with radiation and 110 stages performed without radiation. J. Thoracic Surg., 7, 525-535.
80. Hart, D. 1938 Sterilization of air in operating room by bactericidal radiant energy; results in over 800 operations. Arch. Surg., 37, 956-972.
81. Hart, D. 1940 Is sterilization of air by use of ultraviolet radiation of benefit. Internat. Abstr. Surg., 71, 420-422.
82. Hart, D. 1941 The importance of air-borne pathogenic bacteria in the operating room. A method of control by sterilization of the air with ultraviolet radiation. J. Am. Med. Assoc., 117, 1610-1613.

83. Hart, D. 1944 Air disinfection- In- "Medical Physics". Year Book Publishers, Inc., Chicago.
84. Hart, D., Devine, J.W., and Martin, D.W. 1939 Bactericidal effect of ultraviolet radiation; use of special unit for sterilizing air in operating room. Arch. Surg., 38, 806-815.
85. Henle, W., Sommer, H.E., and Stokes, J., Jr. 1942 Studies on air-borne infection in a hospital ward. II. Effects of ultraviolet irradiation and propylene glycol vaporization on the prevention of experimental air-borne infection of mice by droplet nuclei. J. Pediat., 21, 577-590.
86. Hercik, F. 1936 Action of ultraviolet light on spores and vegetative forms of B. megatherium. J. Gen. Physiol., 20, 589-594.
87. Herzberg, K. 1933 The destruction of vaccine virus by light energy and dyes. Z. Immunitats., 80, 507-520.
88. Hollaender, A. 1942 "Aerobiology". Publ. Am. Assoc. Advancement Sci., 17, 156-165.
89. Hollaender, A. 1943 Effect of long ultraviolet and short visable radiation (3500 to 4900A) on Escherichia coli. J. Bact., 51, 531-541.
90. Hollaender, A. 1943 Ultraviolet irradiation as means of disinfection of air. Am. J. Pub. Health, 33, 980-984.
91. Hollaender, A. 1946 Effects of ultraviolet irradiation. Ann. Rev. Physiol., 8, 1-16.
92. Hollaender, A., and Oliphant, J.W. 1944 The inactivating effect of monochromatic ultraviolet radiation on influenza virus. J. Bact., 48, 447-454.
93. Hollaender, A., and Oliphant, J.W. 1944 The effect of monochromatic ultraviolet radiation on influenza virus as compared with other viruses. J. Bact., 47, 471.
94. Hollaender, A., Stapleton, G.E., and Martin, F.L. 1951 X-ray sensitivity of E. coli as modified by oxygen tension. Nature, London, 167, 103-104.
95. Horwood, M.P., Horton, J.P., and Minch, V.A. 1950 Some effects of ultrasonic vibrations on Escherichia coli. Bact. Proc., 1950, 63.
96. Howze, H.H. 1926 Bactericidal action of ultraviolet light on tubercle bacilli. Am. Rev. Tuberc., 13, 470-474.
97. Imshenetskii, A.A. 1946 Ecology of pigmented microorganisms. I. Protective influence of carotenoids. Mikrobiologiya, 15, 422-427.
98. Johnson, F.H., Flagler, E.A., and Blum, H.F. 1950 Relation of oxygen to photoreactivation of bacteria after ultraviolet radiation. Proc. Soc. Exp. Biol. Med., 74, 32-35.
99. Jungeblut, C.W. 1937 Effect of ultraviolet rays on poliomyelitis virus in vitro. Proc. Soc. Exp. Biol. Med., 37, 160-162.
100. Knowles, T., and Taylor, A.H. 1950 Spectral radiation involved in photoreactivation of ultraviolet-irradiated cultures of microorganisms. Bact. Proc., 1950, 49.
101. Koch, R. Bacteriology Sternberg.
102. Koch, R. 1890 Proc. X Internat. Med. Cong., Berlin.
103. Kutscher, K. 1906 Ueber Untersuchungen der Nasenrachenhöhle gesunder Menschen auf Meningococcen. Deut. med. Wochschr., 32, 1071-1075.

104. Kvasnikov, E.I. 1941 The effect of ultrasonic waves on microorganisms. Khim. Referat. Zhur., 4, 56.
105. Lagerberg, I. 1919 Vergleichende Untersuchung über die Widerstandsfahigkeit der Sporen und der vegativen Formen einiger sporen bildender Bakterien gegen über ultraviolettten Licht. Z. Immunitat., 28, 186-197.
106. Lal, N. 1923 Effect of direct sunlight on sealed cultures of organisms. Indian J. Med. Research, 11, 445-447.
107. Lal, R.B., and Mathur, K.N. 1926 Effects of polarized light on bacterial life; growth of B. coli communis and V. cholerae under polarized light. Indian J. Med. Research, 14, 257-262.
108. Latarjet, R. 1943 Actions primaires comparees des rayons x et ultraviolets sur le bacille paradysenterique Y6R. Ann. Inst. Pasteur, 69, 205-214.
109. Latarjet, R., and Wahl, R. 1945 Precicions sur l'inactivation des bacteriophages par les rayons ultraviolets. Ann. Inst. Pasteur, 71, 336-339.
110. Laurens, H. 1938 The physiologic effects of ultraviolet radiation. J. Am. Med. Assoc., 111, 2385-2392.
111. Lea, D.E. 1947 Actions of radiations on living cells. MacMillan Co., New York.
112. Lea, D.E., and Haines, R.B. 1940 The bactericidal action of ultraviolet light. J. Hyg., 40, 162-171.
113. Lehmann, K.B. 1931 Das Absterben von Eiterkokkenauf Linoleum, Holz, Glas, und Gummi unter Berücksichtigung von Licht und Temperatur. Arch. Hyg., 106, 1-31.
114. Levaditi, C. 1942 Comportement des ultravirus herpetique et poliomyllitique (souch Lansing) a l'egard des radiations ultraviolettes en milieu fluorescent. Compt. rend. soc. biol., 136, 404-405.
115. Lidwell, O.M. 1946 Bacterial effects of the partial irradiation of a room with ultraviolet light. J. Hyg., 44, 333-341.
116. Lidwell, O.M., and Lovelock, J.E. 1946 Some methods of measuring ventilation. J. Hyg., 44, 326-332.
117. Loiseleur, J. 1945 Mode of action of ultrasonic vibration on bacteria. Ann. Inst. Pasteur, 71, 378-380.
118. Luckiesh, M., and Holladay, L.L. 1942 Tests and data on disinfection of air with germicidal lamps. General Electric Review, 45, 223-231.
119. Luckiesh, M., and Knowles, T. 1948 Resistivity of Escherichia coli to ultraviolet energy as affected by irradiation of preceding cultures 2537A. J. Bact., 55, 369-372.
120. Luckiesh, M., Taylor, A.H., Knowles, T., and Leppelmeier, E.T. 1949 Inactivation of molds by germicidal ultraviolet energy. J. Franklin Inst., 248, 311-325.
121. McKinley, E.B., Fisher, R., and Holden, M. 1926 Action of ultraviolet light upon bacteriophage and filterable viruses. Proc. Soc. Exp. Biol. Med., 23, 408-412.
122. Matsuda, S. 1910 Kaigun Guni Kaiho, No. 31.
123. Mayer, E. 1921 Sunlight and artificial light therapy in tuberculosis. Am. Rev. Tuberc., 5, 75-158.
124. Meader, F.M. 1926 Sunlight as disinfectant. J. Michigan Med. Soc., 25, 636-645.

125. Meissner, O. 1940 Die Grippeepedemie 1939 und das Wetter. Bioklimatische Beiblatter, 7, 42-43.
126. Miller, C.P., and Schad, D. 1944 Germicidal action of daylight on meningococci in the dried state. J. Bact., 47, 79-84.
127. Minck, F. 1896 Zur Frage über die Einwirkung der Röntgen'schen Strahlen auf Bakterien und ihre eventuelle therapeutische Verwendbarkeit. Munch. Med. Wochnschr., 43, 101-102.
128. Morse, M.L. 1950 Resistance to ultraviolet radiation in Escherichia coli, strains B and B/r. Bact. Proc., 1950, 135.
129. Mudd, S. 1944 Current progress in sterilization of air. Am. J. Pub. Health, 34.
130. Nasta, M., Jovin, I., and Blechmann, M. 1930 Effect of antiseptics and ultraviolet rays on tubercle bacilli. Compt. rend. soc. biol., 104, 1075-1076.
131. Newcomer, H.S. 1917 The abiotic action of ultraviolet light. J. Exp. Med., 26, 841-848.
132. Nobele, J. de, and Potter, F. de 1928 Action des rayons ultraviolets sur certaines especes microbiennes. Bruxelles-Méd., 8, 883-886.
133. Oker-Blom, M. The nature of the action of ultraviolet light on bacteria. Z. Hyg., 74, 242-247.
134. Osler, W. 1901 Practice of Medicine, 4th Ed.
135. Oster, R.H. 1934 Results of irradiating Saccharomyces with monochromatic ultraviolet light. II. The influence of modifying factors. J. Gen. Physiol., 18, 243-250.
136. Oster, R.H. 1934 Results of irradiating Saccharomyces with monochromatic ultraviolet light. III. The absorption of ultraviolet energy by yeast. J. Gen. Physiol., 18, 251-254.
137. Oster, R.H., and Arnold, W.A. 1935 Results of irradiating Saccharomyces with monochromatic ultraviolet light. IV. Relation of energy to observed inhibitory effects. J. Gen. Physiol., 18, 351-355.
138. Ottosen, H.E. 1945 Studies on Corynebacterium Magnusson-Holth with special references to its serological aspects. Skand. Vet. Tidskr., 35, 635-654.
139. Peacocke, A.R., and Hinshelwood, C.N. 1948 Changes induced in Bacterium lactic aerogenes by irradiation with ultraviolet light. Proc. Roy. Soc. London, 135, 454-461.
140. Perkins, R.G., and Welch, H. 1929 Bactericidal action of ultraviolet light from series of carbon arcs with known spectra; effect of very short exposures; resistance in relation to determination of end point. J. Prev. Med., 3, 363-376.
141. Phelps, E.B., and Buchbinder, L. 1939 The survival rates and resultant pathogenic properties of B. hemolytic streptococci in an experimental room. Symposium on Airborne Infections, 3rd Internatl. Congr. Microbiol. Rept. Proc., New York.
145. Polding, J.B. 1950 Brucellosis in India. Indian Vet. J., 27, 158-170.

146. Polson, A., and Dent, J. 1950 The rate of inactivation by ultraviolet irradiation as a means of distinguishing antigenically different strains of African horse-sickness virus. Brit. J. Exp. Path., 31, 1-4.
147. Raghavachari, I., and Seetharama, I. 1939 Longevity of coliform organisms in water stored under natural conditions. Indian J. Med. Research, 26, 877-884.
148. Rentschler, H.C. 1940 Bactericidal ultraviolet radiation and its uses. Ann. Convention of Illuminating Eng. Soc., 34, 1-16.
149. Rentschler, H.C. 1941 Bactericidal action of ultraviolet radiation. J. Bact., 42, 292.
150. Rentschler, H.C. 1942 Production and control of bactericidal ultraviolet radiation. Aerobiology, No. 17, 166-170.
151. Rentschler, H.C., and Nagy, R. 1940 Advantages of bactericidal ultraviolet radiation in air conditioning systems. Heating, Piping, and Air Conditioning, 12, 127.
152. Rentschler, H.C., Nagy, R., and Mouromseff, G. 1941 Bactericidal effect of ultraviolet radiation. J. Bact., 41, 745.
153. Rivers, T.M. 1939 Viruses and virus diseases. Stanford University Press.
154. Rivers, T.M., and Gates, J. 1928 II. The effect of monochromatic ultraviolet light upon vaccine virus. J. Exp. Med., 47, 45-49.
155. Robertson, E.C. 1940 Ultraviolet light in hospital practice (in prevention of cross infections). Hospitals, 14, 115-118.
156. Robertson, E.C., Doyle, M.E., Tisdall, F.F., Koller, L.R., and Ward, F.S. 1939 Air contamination and air sterilization. Am. J. Diseases Children, 58, 1023-1038.
157. Rosenstern, I. 1942 Observations on the control of respiratory contagion in the Cradle. Aerobiology Am. Assoc. Adv. Sci., No. 17, 242-250.
158. Roux, E. 1887 De l'action de la lumiere et de l'air. Ann. Inst. Pasteur, 1, 445.
159. Rozhin-Kokhanii, I. 1948 The effects of rentgen rays on protein s molecules and microorganisms. Ukrain Tech. Husbandry Inst. Sci. Repts., No. 1 and 4.
160. Rucci, E. 1949 Dissociazione delle brucelle da ultrasuoni. Giorn. Batteriol. e Immunol., 41, 171-173.
161. Scherp, H.W., and Chambers, L.A. 1936 Resistance of the viruses of poliomyelitis, human influenza and swine influenza to intense vibration. Proc. Soc. Exp. Biol. Med., 35, 495-500.
162. Schmidt-Nielsen, S. 1901 Beitrag zur Biologie der marinen Bakterien. Biol. Centr., 21, 65.
163. Schnegg, H., Kipphan, H., and Grunert, K. 1936 Action of ultraviolet radiation on organisms which may be dangerous in the brewery. Z. Ges. Brauw., 59, 21-31.
164. Schofield, F.W. 1916 Pathogenicity and longevity in diphtheria bacilli. Am. J. Pub. Health, 6, 1303.
165. Schwarz, L., and Aumann, N.I. 1911 The action of ultraviolet rays on drinking water. Z. Hyg., 69, 1-16, 68-91.

166. Sharp, D.G. 1938 A quantitative method of determining the lethal effect of ultraviolet light on bacteria suspended in air. J. Bact., 35, 589-599.
167. Sharp, D.G. 1939 The lethal action of short ultraviolet rays on several common pathogenic bacteria. J. Bact., 37, 447-460.
168. Sharp, D.G. 1940 Effects of ultraviolet light on bacteria suspended in air. J. Bact., 39, 535-547.
169. Smit, J. 1931 The process of self-purification in polluted waters. Wasser, 5, 178-192.
170. Smith, C.R. 1942 Survival of tubercle bacilli in books; how contaminated books may be rendered uninfectious. Am. Rev. Tuberc., 46, 549-559.
171. Soloway, M., Seletorovsky, M., and Buchbinder, L. 1942 VII. Further observations on the survival rates of streptococci and pneumococci in daylight and darkness. J. Bact., 43, 545-555.
172. Soparkar, M.B. 1917 Vitality of tubercle bacillus outside the body. Indian J. Med. Research, 4, 627.
173. Stenstrom, W., and Gaida, J.B. 1931 Action of ultraviolet rays on new and old bacterial cultures. Proc. Soc. Exp. Biol. Med., 28, 898-902.
174. Sterckx, R. 1935 Influence of physical and physicochemical factors on microorganisms (yeasts and bacteria). Bull. Assoc. Eleves Inst. Sup. Fermentations Gand., 36, 279-288.
175. Stewart, W. 1944 Viability of dysentery bacilli and transmission by flies in North Africa. J. Roy. Army Med. Corps, 83, 42-46.
176. Strebel. H. 1901 Untersuchungen über die bakterizide Wirkung des Hochspanungsfunken Lichtes. nebst. Angabe einer Methode zur besseren Ausnützung der bakteriziden Kraft des Voltabogen Lichtes. Deut. Med. Wochschrl.,27,69-72,87-87.
177. Sugiyama, T. 1951 Electric energy as a lethal, lytic and antigen-extractive agent for bacterial cell. I. The lethal and lytic action, with special reference to the efficacy on spore-bearing bacteria. Kitasato Arch. Exp. Med., 23, 33-45.
178. Sutton, N.I. 1941 J. Australian Inst. Agr. Sci., 7, 67-73.
179. Tang, P.S., and Gaw, H.Z. 1937 Mechanism of death in unicellular organisms. I. Delayed death and change in resistance to ultraviolet radiation in paramecium bursaria with age of culture. Chinese J. Physiol., 11, 305-314.
180. Taylor, A.R., Sharp, D.G., Beard, D., Finkelstein, H., and Beard, J.W. 1941 Influence of ultraviolet light on equine encephalomyelitis virus protein (eastern strain). J. Infectious Diseases, 69, 224-231.
181. Toomey, J.A. 1937 Inactivation of poliomyelitis virus by ultraviolet irradiation. Am. J. Diseases Children, 53, 1490.
182. Ukil, A.C., and Basu, M.M. 1927 Action of tropical sunlight on bacteria. Calcutta Med. J., 21, 536-539.
183. Vaindrakh, G.M. 1939 The influence of ultra short waves on microorganisms and the mechanism of their action. J. Microbiol. Epidemiol. Immunobiol., No. 7-8, 156-157.

184. Ward, H.M. 1890-1894 Proc. Roy. Soc., London.
185. Ward, H.M. 1892 Proc. Roy. Soc., London, 52, 393.
186. Ward, H.M. 1894 Further experiments on the action of light on *Bacillus anthracis*, and on the bacteria of the Thames. Proc. Roy. Soc., London, 56, 315-395.
187. Ward, H.M. 1894-1895 Action of light on bacteria and fungi. Notices Proc. Roy. Inst. Great Britain, 14, 259-279.
188. Weinzirl, J. 1907 The action of sunlight upon bacteria with special reference to B. tuberculosis. J. Infectious Diseases, Sup. 3, 4, 128-153.
189. Weinzirl, J. 1914 The germicidal action of sunlight upon bacterial spores. Am. J. Pub. Health, 4, 969-974.
190. Wells, D.A. 1929 Lethal action of ultraviolet light on microorganisms in a high vacuum. Nature, London, 124, 693.
191. Wells, D.A. 1931 Action of low velocity electrons on microorganisms. Bull. Basic Sci. Research, 3, 5-20.
192. Wells, W.F. 1935 Air-borne infection and sanitary air control. J. Indust. Hyg., 17, 253-257.
193. Wells, W.F. 1940 Biological factors involved in the bactericidal irradiation of air. J. Bact., 39, 18.
194. Wells, W.F. 1940 Bactericidal irradiation of air. I. Physical factors. J. Franklin Inst., 229, 347-372.
195. Wells, W.F. 1941 Infection, disinfection, and air conditioning. Ind. Med., 10, 281-282.
196. Wells, W.F. 1942 Radiant disinfection of air. Arch. Phys. Therapy, 23, 143-148.
197. Wells, W.F. 1943 Air disinfection in day schools. Am. J. Pub. Health, 33, 1436-1443.
198. Wells, W.F. 1945 Circulation in sanitary ventilation by bactericidal irradiation of air. J. Franklin Inst., 240, 379-395.
199. Wells, W.F. 1945 Sanitary ventilation by radiant disinfection. Sci. Monthly, 60, 325-334.
200. Wells, W.F., and Brown, H.W. 1936 Recovery of influenza virus suspended in air and its destruction by ultraviolet radiation. Am. J. Hyg., 24, 407-413.
201. Wells, W.F., and Fair, G.M. 1935 Viability of *B. coli* exposed to ultraviolet radiation in air. Science, 82, 280-281.
202. Whistler, B.A. 1940 The efficacy of ultraviolet light sources in killing bacteria suspended in air. Iowa State Coll. J. Sci., 14, 215-231.
203. Whitney, R., and Russell, L. 1951 An experimental approach to problems of control in quantitative studies of ultrasonic bactericidal effects. Food Research, 16, 205-215.
204. Witkin, E.M. 1947 Genetics of resistance to radiation in *Escherichia coli*. Genetics, 32, 221-248.
205. Wood, F.C. 1905 The viability of the pneumococcus after drying: a study of one of the factors in pneumonic infection. J. Exp. Med., 7, 592-625.
206. Wyckoff, R.G. 1932 The killing of colon bacilli by ultraviolet light. J. Gen. Physiol., 15, 351-361.
207. Yasuhara, Y. 1933 Experiments on sea water and vibrio cholerae. Jap. J. Exp. Med., 11, 119.

208. Zeit, F.R. 1901 Effect of direct, alternating, Tesla currents and X-rays on bacteria. J. Am. Med. Assoc., 37, 1432-1442.
209. Zinsser, H., and Hopkins, J.G. 1914 The viability of *Spirochaeta pallida* in diffuse light at room temperature. J. Am. Med. Assoc., 62, 1802.
210. ZoBell, C.E., and McEwen, G.F. 1935 Lethal action of sunlight upon bacteria in sea water. Biol. Bull., 68, 93-106.

1a. Bamberger, A. 1936 Resistance of dysentery and pseudodysentery bacilli to external influences. Zentralbl. F. Bakt. (Abt. 1), 137, 142-151.

2a. Beckwith, T.D., and Weaver, C.E. 1936 Sonic energy as a lethal agent for yeast and bacteria. Jour Bact., 32, 361-373.

3a. Bruynoghe, R., and Mund, W. 1925 Action of Radium on microbes. Comp. Rend. Soc. de Biol., 92, 211-212.

4a. Bruynoghe, L., and Mund, W. 1925 Irradiated microbes and bacteriophage. Compt. Rend. Soc. de Biol. 92, 464-465.

5a. Buchbinder, L., Soloway, M., and Phelps, E.B. 1941 In simulated room environments; effect of survival on pathogenic properties of Streptococci; in presence of natural, daylight and sunlight, and artificial illumination. Jour. Bact., 42, 79.

6a. Buchbinder, L., Solowey, M., and Phelps, E.B. 1941 Survival rates of Streptococci in the presence of natural daylight and sunlight and artificial illumination. Jour. Bact., 42, 353.

7a. Buchbinder, L. 1942 The bactericidal effects of daylight and sunlight on chained gram positive cocci in simulated room environment; theoretical and practical considerations. Aerobiol. No. 17, 267-270.

8a. Buttolph, L.J., 1944 Physical basis of air disinfection by Ultra-Violet energy. Arch. Phys. Therapy, 25, 671-682.

9a. Buttolph, L.J. 1945 Principles of Ultra-Violet disinfection of enclosed spaces. Fleat. Pip., and Air Cond.(Ashve. Jour. Sect.) 17, 282.

10a. Cathcart, W.H., Ryberg, R.E., and Merz, A. 1942 Staphylococci and Salmonella control in foods; effect of Ultra-Violet radiation and ozone on bakery custard and cream fillings. Food Res., 7, 1-9.

11a. Dognon, A. 1930 Resistance of bacteria to low air pressure; possibilities of biological study of slightly penertrating rays. Compt. Rend. Soc. de Biol., 103, 886-887.

12a. Fram, Harvey, Proctor, Bernard, E., and Dunn, Cecil, G., 1950 Effects of X-rays produced at 50 Kilovolts on different species of bacteria. Jour. Bact., 263-267.

13a. Giese, A.C. 1945 Physiol. Zool., 18, 223-250.

14a. Grabar, P., Rouyer, M. 1945 Disintegration of bacteria by ultrasounds. Amer. Inst. Pasteur, 71, 154-157.

15a. Grancher, and Richard 1889 Action du sol sur les microbes pathogenes. Rev. Scient.,(Par.), 10, 365-369.

16a. Gutfeld, Fritz V., and Pincussen, Ludwig 1928 Investigations on the action of light on bacteria. Centr. Bakt. Parasitenk., 1 Abt. 109, 107-115.

17a. Hart, D. 1937 Control of air-borne pathogenic organisms, with particular reference to the use of special bactericidal radiant energy; (Pre. Rept.) Arch. Surg., 34, 874.

18a. Henle, W., Sommer, H.E., and Stokes, J., Jr. 1942 Studies on air-borne infection in a hospital ward. 11. Effects of Ultra-Violet irradiation and propylene glycol vaporization on the prevention of experimental air-borne infection of mice by droplet nuclei. Jour. Pediat. 21, 577-590.

19a. Jarrett, E., Zelle, M., Hollaender A. 1948 Studies of the control of acute respiratory disease among naval recruits. 11. Limitation of Ultra-Violet irradiation in reduction of air-borne bacteria in barracks with low ceilings. Amer. Jour. Hyg., 48, 233-239.
20a. Kutscher, K. 1906 Ueber Untersschungen der Nasenrachen-höhle gesunder Menschen auf Menigococcen. Deut. Med. Wochschr., 32, 1071-1075.
21a. Latarjet, R., Morenna, P. 1951 Inactivation of a bacteriophage by Ultra-Violet rays of a very low intensity. Ann. Inst. Pasteur, 80, 220-224.
22a. Mayer, Edgar, and Dwordki, Morris 1924 Studies with Ultra-Violet light. 111. The bactericidal action of Mercury-Quartz-vapor light irradiation. Amer. Rev. Tuberc., 10, 166-169.
23a. Miller, W.R., Jarrett, E.T., Wilman, T.L., Hollaender, Alex 1948 Evaluation of Ultra-Violet radiation and dust control measures in control of respiratory diseases at a Naval training center. Jour. Infect. Dis., 82, 86-100.
24a. Rossi, C. 1924 Sull'azione battericida della luce Solare in Profondità. Ann. Ital. di Chir., Napoli, 3, 1000-1020.
25a. Tanner, F.W. and Appling, J.W. 1941 Bactericidal effect of Ultra-Violet rays (sterilamp) on non-spore forming bacteria and mold spores. Proc. Soc. Expertl. Biol. and Med., 47, 47-51.

References (Radiation) Addendum

1a. Anderson, T.F., Boggs, S., and Winters, B.C. 1948 The relative sensitivities of bacterial viruses to intense sonic vibration. Science, 108, 18.

2a. Burnet, F.M. 1925 Hydrogen peroxide and bacterial growth. Aust. J. Exp. Biol. Med. Sci., 2, 65.

3a. Dick, G.W.A., Schwerdt, C.E., Huber, W., Sharpless, G.R., and Howe, H.A. 1951 Immunization of cotton rats with inactivated Lansing p oliomelitis. II. Inactivation by physical methods. Am. J. Hyg., 53:2, 131-138.

4a. Gunderson, T. 1932 Germicidal effect of ultraviolet rays on virus of Herpes; experimental studies. Arch. Ophthalmol., 8, 519-529.

5a. Gutfeld, Fritz V., and Pincussen, Ludwig 1928 Investigations on the action of light on bacteria. Centr. Bakt. Parasitenk., 1 abt. 109, 107-115.

6a. Hart, D. 1937 Control of air-borne pathogenic organisms, with particular reference to the use of special bactericidal radiant energy; (Pre. Rept.) Arch. Surg., 34 874.

7a. Hollaender, A., DuBuy, H., Ingraham, H., and Wheeler, S.M. 1944 Control of air-borne microorganisms by ultraviolet floor irradiation. Science, 99, 130-131.

8a. Jarrett, E., Zelle, M., Hollaender, A. 1948 Studies of the control of acute respiratory disease amoung naval recruits. II. Limitation of ultra-violet irradiation in reduction of air-borne bacteria in barracks with low ceilings. Amer. J. Hyg., 48, 233-239.

9a. Kraissl, C.J., Wilson, D.A.W., and Wilson, M.H. 1942 Clinical and laboratory observations in the use of ultraviolet radiation in surgery. Aerobio logy , 17, 197-205.

10a. Latarjet, R., Morenna, P. 1951 Inactivation of a bacteriophage by ultra-violet rays of a very low intensity. Ann. Inst. Pasteur, 80, 220-224.

11a. McCulloch, E.C. 1945 Disinfection and sterilization.

12a. Mayer, Edgar, and Dwordki, Morris 1924 Studies with ultra-violet light. III. The bactericidal action of mercury-quartz-vapor light irradiation. Amer. Rev. Tuberc., 10, 166-169.

13a. Miller, W.R., Jarrett, E.T., Wilman, T.L., Hollaender, Alex 1948 Evaluation of ultra-violet radiation and dust control measures in control of respiratory diseases at a Naval training center. J. Infect. Dis., 82, 86-100.

14a. Nicoll, W. 1917 Observations on the influence of salt and other agents in modifying the larval development of hookworms: Ankylostoma doudenale and Necator americanus. Parasitol., Cambridge, 9, 157-189.

15a. Philibert, A., and Risler, J. 1926 Effects of neon light on bacteria. Compt. Rend. Acad. Sci., 183, 1137-1139.

16a. Rahn, Otto 1932 Physiology of bacteria.

17a. Tanner, F.W. and Green, H. 1930 Residual germicidal action of water and plain agar after exposure to ultraviolet irradiation. Proc. Soc. Exp. Biol. Med., 28, 291-293.

18a. Tanner, F.W. and Appling, J.W. 1941 Bactericidal effect of ultra-violet rays (sterilamp) on non-spore forming bacteria and mold spores. Proc. Soc. Exp. Biol. Med., 47, 47-51.

19a. Topley and Wilson 1946 Principles of bacteriology and immunity.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
$>$	greater than
$<$	less than
$+$	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN SOIL

TABLE 51 THE SURVIVAL OF BACILLUS SPECIES IN SOIL

Factor(s)	Survival	Reference	
MUD			
B. subtilis			
Black mud, dark, moist	Recov. O, >80 d.	Rubentschik	1936
B. cereus var. mycoides			
Black mud dark, moist	Recov. O, " "	"	"
GENERAL			
B. anthracis			
Soil and manure 3 cm. deep	Spores-10 wk.	Beranek	1948
Surface soil	12 yr.	Pasteur	1881
Dry ster. soil, 3% moist.	Sporulation of possible	Minett	1950
Ster. muddy water stored in a pond on the plains of India	Survived over 2 yr.	"	"
Soil	More or less permanent habitat	Sanyal	1941
Moist or dry earth	33 mo.	Sirena	1894
Soil over burial place of dead anthrax animals	15 yr.	Wencke	1900
Gravel, carcasses buried 20 yr.	20 yr.	"	"
B. subtilis			
Soil 400 meters deep, 30C	Inoc. Bouillon & 27% watt extract with 2% agar, recov. growth, 1-8 d.	Lieske	1929
B. spp.			
B. cereus, megatherium, and mycoides in ster. soil	Multiply 1st. 40 d., dec. and at end of 85 still dec.	Katznelson	1940
Soil 500-600 meter deep, 30C	Inoc. into beef extract pepton-bouillon & 2% malt extract with 2% agar, growth 1-8 d.	Lieske	1929

TABLE 32 THE SURVIVAL OF BRUCELLA SPECIES IN SOIL

Factor(s)	Survival	Reference	
SAND			
B. suis			
Sand	120 d.	Bryan	1934
GENERAL			
B. abortus			
Unheated cellar Oct., dried quickly	<4 d.	Cameron	1932
Unheated cellar Feb., dried quickly	27 d.	"	"
Test tubes, lab temp., dried slowly	37 d.	"	"
Wet soil, unheated cellar	66 d.	"	"
B. melitensis			
Soil, favorable conditions	10 wk.	Bang	1897
Damp ster. soil	72 d.	Horrocks	1906
Dry ster. manure soil	69 d.	"	"
Moist ster. " "	7 d.	"	"
" unster. manure soil	20 d.	"	"
B. suis			
Soil	46 d.	Bryan	1934
B. sp.			
Soil in pastures where animals excrete large amounts of org.	Poor survival	Christiansen	1950

TABLE 53 THE SURVIVAL OF CLOSTRIDIUM SPECIES IN SOIL

Factor(s)	Survival	Reference	
LOAM			
C. botulinum			
Soil from counties in Md. where veg. grow	A, B, & C strains isolated	Damon	1926
C. tetani			
Sandy loam - corn	Isolated	"	"
SAND			
C. botulinum			
Veg. grown in sandy soil in counties of Md.	Isolated	Damon	1926
GENERAL			
C. botulinum			
Soil in central N.Y., pH 4.25-8.5	Type A more predominant than type B, toxic cult. type A, greater % of toxic cult. from cultivated soil	Parry	1946
Soil	More or less permanent habitat	Sanyal	1941
C. tetani			
Soil	More or less permanent habitat	"	"
"	Found	Dubovsky	1922
Soil of school ground	"	Ishihara	1933
C. perfringens (welchii)			
Soil	More or less permanent habitat	Sanyal	1941
C. tetani (cont'd)			
Soil	Years	T. & W.	1946
English soil plus botulinum	Found	Haines	1942
Soil from alley near stable	"	Foraker	1941

TABLE 34 THE SURVIVAL OF COLIFORM IN SOIL

Factor(s)	Survival	Reference
LOAM		
Escherichia coli		
Rich loam, R.T.	Recov. unchanged 1 mo.	Horrocks 1903
Virgin loam	" " 6 wk.	" "
Sandy and clay loam	" 5.4logs/100gm, 0 wk.	Mallmann 1951
" " " "	Recov. 3.8 logs/100gm, 11 wk.	" "
MUD		
E. coli		
Mud with infected water outside temp.	Demonstrable 45 d.	Bartos 1947
Tidal mud	3 mo.	Savage 1905
SAND		
E. coli		
Virgin sand	Recov. unchanged 60 d.	Horrocks 1903
Sand	Recov. 4.9 logs/100gm. 0 wk.	Mallmann 1951
"	Recov. 0.8 " " ", 11 wk.	"
1 cc. sea sand	Inoc. 48 hr. broth cult, Recov. 0.02/gm, 240hr.	Winslow 1912
Sand, 69C, R.H. 90%	Recov. 67.23/gm, 8 hr.	" "
" " " 72%	" 44.48/gm, 10 hr.	" "
" 70C, " 60%	" 37.46/gm, 7 hr.	" "
GENERAL		
E. coli		
Ordinary soil and sewage	53-65 d.	Firth 1902
Tomatoes grown on soil with sewage	1 mo.	Falk 1949
Soil fertilized with chicken manure, 72C	Inoc. 10^{-3}, Recov. 10^{-3}, 7 d.	Ostrolenk 1947
Soil fertilized with chicken manure, R.T.	Inoc. 10^{-7}, Recov. 10^{-2} 150 d.	" "
Normal feces stored with garden soil, R.T.	12 wk.	Jordan 1926
Normal feces stored with beach sand, R.T.	6-8 wk.	Chick 1900
Roads, dry	Short time	" "
" wet	Much longer	" "
Garden soil, ster. with dry heat	Inoc. ½ soil strain & ½ fecal strain, 2 mo., found in 2 gm.	Fellow 1923
Soil	Inoc. 1 bouillon/liter water, persistant 410d.	Klein 1935
Ster. soil, 18-20C, dark, moistened with ster. water	> 4 mo.	Koser 1924
Ster. garden soil	Living after 3 yr. 7 mo.	Kulp 1932
Soil, 60% moisture, sterilized with dry heat	Isolated 17 mo. later	Fellow 1923

TABLE 54 (CONT'D) THE SURVIVAL OF COLIFORM IN SOIL

Factor(s)	Survival	Reference	
GENERAL (cont'd)			
E. coli			
Soil, 40-20-10% moisture, ster. with dry heat	Isolated 17 mo. later	Fellow	1923
Soil, 100% moisture, air dried	None at end 1 mo.	"	"
Soil, 60% moisture, air dried	" in 10 gm. in 2 mo.	"	"
Soil, 40-20-10% moisture, air dried	Fecal & soil strain present at end of 34 mo.	"	"
Dry soil	25 d.	Firth	1902
Soil	6-8 wk.	Horrocks	1903
"	6-8 wk.	Houston	1897
Virgin soil	E. coli generally absent	"	"
Unfertilized soil, R.T.	Inoc. 10 gm., Recov. 10 gm., 66 d.	Ostrolenk	1947
Soil with pecans, R.T., artifical infection	Inoc. 10^{-7}, Recov. 10^{-6}, 106 d.	"	"
Soil	8 mo.	Previtero	1945
"	Low temp., moisture, organic matter, and absence of other org. inc. the viability	Rudolfs	1950
Tomatoes grown on polluted soils	Death rate slow in storage, soaking in water at 60C for 5 min. most effective	"	1951
Street scrapings	4 yr.	Savage	1904
Soil	Inoc. 600,000, Recov. 5, 122 d.	Skinner	1926
"	Inoc. 9,000,000; Recov. 5, 176 d.	"	"
" , with E. coli and A. aerogenes	Inoc. 1,300,000; Recov. 5, 176 d.	"	"
Dry soil	8 d.	Tanner	1944
Moist soil	>60 d.	"	"
Ster. garden soil, 100% moisture	Recov. 0, <1 yr.	Young	1923
Ster. garden soil, 60-40-30-10% moisture	" " >17 mo.	"	"
Unster. garden soil, 1 cc. susp'n 100% saturation	1 mo.	"	"
Unster. garden soil, 60% saturation of 1 cc. susp'n	2 mo.	"	"
Unster. garden soil, 1 cc. susp'n 40-20-10% sat.	>17 mo.	"	"
Soils	4 yr.	"	"
Aerobacter aerogenes			
Ster. garden	Living after 3 yr. 7 mo.	Kulp	1932
Soil	Inoc. 13,000,000; Recov. 50, 218 d.	Skinner	1926
Soil, plus E. coli	Inoc. 800000, Recov. 80, 218 d.	"	"

TABLE 54 (CONT'D) THE SURVIVAL OF COLIFORM IN SOIL

Factor(s)	Survival	Reference	
GENERAL			
Enteric bacteria			
Ster. originally contaminated soil, 3-19 C	>404 d.	Martin	1896
Above dried to powder, 3-19C	>4 d.	"	"
Ster. virgin peaty soil, 3-19C	<1 d.	"	"
Unster. soil, 3-19C	>50 d.	"	"
Ster. dry soil, 2-12C	57 d.	"	1898
Unster. dry soil, 2-12C	12 d.	"	"

TABLE 52 THE SURVIVAL OF CORYNEBACTERIUM DIPHTHERIAE IN SOIL

Factor(s)	Survival	Reference
SAND		
Fine sand, 37C with cult. dried in air	Recov. 0, 30 d.	Germano 1897
Fine sand, 37C, with cult. dried over H_2SO_4	" " 50 d.	" "
Sand	175 d.	Laurell 1949
"	>98 d., Recov. mostly with unimpaired toxicity	Ouchterlony 1949
GENERAL		
Soil at 37C, dried in air	Recov. 0, 25 d.	Germano 1897
" " " " over H_2SO_4	" " 35 d.	" "
Soil	208 d.	Laurell 1949
Soil	>98 d., recov. mostly with unimpaired toxicity	Ouchterlony 1949
Soil drained	May be killed	Sharp 1896

TABLE 56 THE SURVIVAL OF FUNGI, YEASTS AND MOLDS IN SOIL

Factor(s)	Survival	Reference	
PEAT			
Actinomyces			
Strongly acid peat soil	Fewest occured	Jensen	1930
GENERAL			
Malleomyces mallei			
Pasture	Unsafe for at least 1 yr.	Lovell	1944
Actinomyces			
Soil, April-May	150-160 million/g. dry soil	Eggleton	1934
Dry soil, hot summer mo.	110-120 " "	"	"
Any " Sept. inc. in moisture	130-140 " "	"	"
Soil, winter	110-120 " "	"	"
Strongly acid pH < 5	Few	Jensen	1930
Soil, pH 6.8-8	Highest no.	"	"
Field frozen over 2 mo., 20C	Actinomycetes made up 30% of total no.	Lochhead	1925
Field, 3C	No Actinomycetes found	"	"
1 gm. of field soil	Contains 10T-20M	Waksman	1927
Actinomyces bovis			
Soil	More or less permanent habitat	Sanyal	1941
Fungi general			
Soil in autumn	Higher than spring	Eggleton	1934
1 gm. field soil	Contains 10T-20M fungi	Waksman	1927
Yeasts general			
Soil	< 1 mo.	Owen	1948
Spores in soil	Lasted thru winter	Tanner	1944
Yeast in soil under natural conditions	Live for long periods of time	"	"
Mold general			
Soil, -2 to -14C	Activity was unaffected	Demoussy	1929
Fungi general (cont'd)			
Seed-bed soil	Disinfected by solar energy	Grushevoi	1940

TABLE 51 THE SURVIVAL OF MICROORGANISMS IN SOIL

Factor(s)	Survival	Reference	
CLAY			
<u>Agrobacterium tumefaciens</u>			
Clay	539 d.	Patel	1929
LOAM			
<u>Agrobacterium tumefaciens</u>			
Loam	587 d.	Patel	1929
MUD			
<u>Pasteurella tularensis</u>			
Mud naturally contaminated and stored in cold	12 wk.	Parker	1943
Uncontaminated mud	" "	Steinhaus	1945
PEAT			
<u>Vibrio comma</u>			
Independent of amount of moisture	24-26 hr.	Dempster	1894
SAND			
<u>Diplococcus pneumoniae</u>			
Dried cult. mixed with sand and veg. oil	2 d.	Germano	1897
<u>Agrobacterium tumefaciens</u>			
Sand	669 d.	Patel	1929
<u>Vibrio comma</u>			
White crystal sand	4 d.	Dempster	1894
Moist white crystal sand	>7 d.	"	"
Yellow sand	4 d.	"	"
Moist yellow sand	>33 d.	"	"
Excess moist white crystal sand	> 28 d.	"	"
Excess moist yellow sand	>68 d.	"	"
White crystal sand, moisture allowed to evap.	3-8 d.	"	"
White crystal sand, moisture not evap.	> 47 d.	"	"
White crystal sand, 1.57% moisture	27 d.	"	"
White crystal sand, 0.66% moisture	30 d.	"	"
White crystal sand evap. prevented, 7.1% moisture	>174 d.	"	"
VOLCANIC ASH			
<u>Diplococcus pneumoniae</u>			
Dried cult. and mixed with volcanic ash, kept moist	6 d.	Germano	1897
GENERAL			
<u>Leptospira icterohaemorrhagiae</u>			
Polluted soil	3 d.	Noguchi	1918
<u>Leptospira sp.</u>			
Wet ground from mines	months	Buchanan	1927
<u>Pseudomonas fluorescens</u>			
Soil	45 d.	Katznelson	1940
Dried blood or alfalfa added to soil	Disappeared from soils	"	"

TABLE 51 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN SOIL

Factor(s)	Survival	Reference	
GENERAL			
Leptospira grippo-typhosa			
High degree soil humidity with hot weather	Favors presence, may enter skin if person is in contact with mud or water that is infected	Kathe	1945
Vibrio comma			
Garden earth	4 d.	Dempster	1894
Moist garden earth	> 33 d.	"	"
Excess moist garden earth	> 68 d.	"	"
Soil, no moisture	1-2 d.	"	"
Azotobacter spp.			
Soil, dark	10X nos. in soil in sun	Dhar	1939
Acid soils	< 24 hr.	Katznelson	1940
Lime and soil	Survived	"	"
Lime and dextrose and soil	Multiplied	"	"
Pure cult. in ster. soil	Multiplied upto 40 d. then dec. Still dec. at 85 d.	"	"
Indiam & Malayan soil, pH 3.6-3	Capable of growing but limit on acid side	Waksman	1940
Soil	Present	Vandecavege	1934
Soils most frequently fertilized with manure	Showed largest no. of azotobacter	Kanivets	1938

TABLE 58 THE SURVIVAL OF MICROORGANISMS IN SOIL (GENERAL)

Factor(s)	Survival	Reference	
GENERAL			
Cult. of legume bacteria in glass bottles, extended exposure to uv. light, on dried soil	No serious injury	Albrecht	1930
on natural soil	Viable 7 yr.	"	"
Soil	Survives extremes of moisture & temp., absence of host, and wind and dust storms to some extent	Vandecaveye	1927
Lactic acid bacteria in ster. garden soil	5 yr.	Barthel	1924
Anthracite coal from Wales & Penna	5 hr. in autoclave does not kill all org., 50 hr. in hot air oven does not kill all org.	Lipman	1931
Denitrifying & ammonifying exposed to -20 and 7C	1-10 wk. were not injured	Bryan	1935
Nitrifying bacteria, -20 & 7C	1-10 wk. were injured	"	"
Ammonifying, nitrifying & N-fixing org., -2 & 14C	Activity unaffected	Demoussy	1929
Bacteria in soil, April-May	150-160 million/g dry soil	Eggleton	1934
Bacteria in soil, hot summer mo., no moisture	110-120 million/g	"	"
Bacteria in soil, Sept. moisture	130-140 million/g	"	"
Bacteria in soil, winter	110-120 million/g	"	"
Soil bacteria, 10C, cult. of synthetic glucose agar	Greatest survival 24 mo. produces a rather permanent change in their nitrifying flora	Greaves	1944
Soil bacteria, 40C, cult. of synthetic glucose agar	Least survival at 24 mo. materially reduced N-fixing powers	"	"
Sulfur & Fe bacteria in soil 400-1089 meters deep, R.H. high, 30C, Inoc. into beef extract-pepton bouillon & 2% malt extract with 2% agar	1-8 d.	Liesky	1929
Bacteria in 1 gm. of field soil	Contains 100 million - 3 billion	Waksman	1927
Addition to fresh soil of washed susp'n of living bacteria	Resulted in their rapid death	Waksman	1940
Sea water and mud, 30C	25% killed, 10 min.	Zobell	1940
Field soil frozen over 2 mo. developed on albumin agar, 20C	Non-sporulating short rods, non-liquifying or slow liquifying most abundant	Lochhead	1925

TABLE 28 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN SOIL (GENERAL)

Factor(s)	Survival	Reference	
GENERAL (cont'd)			
Field soil frozen over 2 mo. developed on albumin agar, 3C	Non-liquifying short rods predominated. No. of col. at 3C 10% of no. at 20C	Lochhead	1925
Aerobes in black mud of "dry estuars" near Odessa stored since 1901 in sealed tube with CO_2 or H_2	Inoc. 300,000-400,000/g. of mud, still alive	Rubenchik	1935
Anaerobes as above	Inoc. 64000-72000/g. of mud, still alive	"	"
Bacteria activity closely correlated with solar energy as expressed in air, soil temp., & light intensity.		Feher	1930
Soil suppresses growth of microorg. in agar on petri dishes.		Novogroundsky	1948
Influence of pH, water, illumination, and air on microflora.		Bokor	1926
Sterilization of soil and its effect on bacteria.		Hall	1950
Bacteria in polluted soil.		Heiser	1917
Sporebearing bacteria found in soil.		Laubach	
Microorg. in soil found in interior of vegetables.		Remlingen	1909
Microorg. in soil.		Rossi	1931
Bacteria salmonicida in river water and silt survives 12 wk.		Slack	1937
Inc. in no. of bacteria in frozen soils is result of breaking up of bacteria clumps rather than actual inc. in nitrifying bacteria.		Bryan	1935
Ordinary soil conditions unfavorable to high antibiotic production as a rule & also to sporulation of molds, inactivating agents are frequent in soil.		Ciferri	1949
CO_2 in soil result of activity of soil microbes. Definite correlation between seasonal changes in soil microbes and CO_2 production. CO_2 content of lower layer of the atmosphere beneath the forest is influenced by soil respiration.		Feher	1938

TABLE 21 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN SOIL

Factor(s)	Survival	Reference	
GENERAL			
M. tuberculosis			
Under covering of snow, -10C	6 wk.	Galtier	1887
Soil	3-3½ mo. still virulent	Loesener	1896
Soil, dung and pasture, summer and autumn	Living and virulent at 178 d.	Maddock	1933
Cow's feces exposed on pasture land, 8-7 lb.,			
winter	Recov. O, 5 mo.	Williams	1930
spring	" " 2 mo.	"	"
autumn	" " 4 mo.	"	"
summer	" " 2 mo.	"	"
Cow's feces, 7-8 lb. exposed on pasture land, protected from sun in summer	4 mo.	"	"
protected from earthworms in autumn	6 mo.	"	"
Soil, dung and pasture land summer and autumn	2-6 mo.	"	"
12 guinea pigs kept outdoors, grazed on infected grass, grass infected 4x one mo. apart	Inoc. 12,000,000 org./sq. ft. of grass; 2 died of pneumonia, 8 out of 10 infected with tuberculosis	Maddock	1934
12 guinea pigs in shed and fed on cut infected grass, 2 oz./pig/day	6 out of 12 contracted tuberculosis	"	"
Garden soil & canal liquid manure exposed to noon sun	123 d.	Musehold	1900
Garden soil left & canal liquid manure exposed to weather conditions	148 d.	"	"
Garden soil & canal liquid manure exposed to all weather and noon sun	66 d.	"	"
M. tuberculosis (bovine)			
Pure culture mixed with cow manure exposed 2" layer in pasture in sunshine	Alive and virulent for 2 mo.	Briscoe	1912
shade	Longer time	"	"
garden soil	>213 d. <230 d.	"	"
Soil in South of Eng., summer	49 d.	Maddock	1933
Pasture land	Survive well	Williams	1930
M. tuberculosis (avian)			
Toluol sterilized soil	3 mo.	Rhines	1935
Unster. soil	>33 d.	"	"
Barn yards	12 mo.	Schalk	1928
M. tuberculosis (cont'd)			
Soil & sewage if properly	treated is free of org.	Pramer	1950

TABLE 5/0 THE SURVIVAL OF PROTOZOA AND METAZOA IN SOIL

Factor(s)	Survival	Reference	
CLAY			
Ascaris lumbricoides			
Eggs, clay summer temp. on surface in shade in S.W. Va.	2 mo.	Otto	1929
On surface in sun in S.W. Va., summer temp.	Recov. ¼ eggs isolated still alive, 160 d.	"	"
Soil, sun	71% motile, 21 d.	Brown	1927
" shade	85% " " "	"	"
Necator americanus			
Clay & humus, R.H. 41.4%, tin sleeve containers	Recov. 6%, 9 d.	Payne	1922
LOAM			
Ascaris lumbricoides			
Human ascaris eggs, summer temp., on surface in shade in S.W. Va.	2 mo.	Otto	1929
On surface in sun, S.W. Va., summer temp.	Recov. ¼ eggs, 160 d.	"	"
Soil, shade	89.3% motile, 21 d.	Brown	1927
" sun	54% " " "	"	"
Necator americanus			
5-8 d. old cult. larva, moist clay loam	Inoc. 1,100, Recov. 18, 26 d.	Augustine	1922
5-8 d. old cult. larva, moist clay loam sod	Inoc. 392, Recov. 5, 26 d.	"	"
5-8 d. old cult. larva, moist red clay loam	Inoc. 500, Recov. 9, 26 d.	"	"
SAND			
Ascaris lumbricoides			
Human eggs, on surface in shade in S.W. Va., summer temp.	2 mo.	Otto	1929
On surface in sun, S.W. Va., summer temp.	Recov. ¼ eggs isolated still alive, 160 d.	"	"
Soil, sun	Recov. 0, 21 d.	Brown	1927
" shade	90.8% motile embryos, 35 d.	"	"
Necator americanus			
5-8 d. old cult., moist sand	Inoc. 498 larva, Recov. 91, 15 d.	Augustine	1922
Trichuris trichiura			
Soil, shade	74% motile, 35 d.	Brown	1927
GENERAL			
Ascaris lumbricoides			
Veg. on soils manured with human feces	Found	Heeger	1949
Eggs buried in ground with thin layer, winter	150-180 d.	Yoshida	1920
Endamoeba histolytica			
Cysts in soil & feces, R.T., & 14C for 4 hr.	8 d.	Beaver	1949
Cysts in soil & feces & water, R.T. 1 hr.	6 d.	"	"

Factor(s)	Survival	Reference	
GENERAL (cont'd)			
Endamoeba histolytica			
Cysts in soil, feces & water, 14C 12 hr.	4 d.	Beaver	1949
Veg. fertilized by feces	A factor in spread of dysentery as part played by handlers	Winfield	1939
Necator americanus			
Larva in moist soil, outside temp., incubated 6-7 d., left in shade	Few existed at end of 7-9 wk.	Augustine	1923
Larva in moist soil, incubated 6-7 d., outside temp., mod. shade	Almost complete dying out at 5½ wk.	"	"
Larva in moist soil, incubated 6-7 d., outside temp., direct sun	1 seen at end of 1 wk.	"	"
Dry soil, dense shade	Recov. 0, > 1 mo.	"	"
" " mod. shade	Recov. 0, 10 d.	"	"
" " direct sun	" " 5 d.	"	"
" " 16C	Inoc. 345, Recov. 0, 17½ wk.	"	"
" " 20-31C	Inoc. 335, Recov. 0, 7wk.	"	"
" " 27C	" 341, " " 11 wk.	"	"
" " 40C	Recov. 0, 1 wk.	"	"
" " 35C	" " 3 "	"	"
" " 16C	" " 14 wk.	"	"
" " 27C	" " 11 wk.	"	"
Soil, favorable conditions	6-12 wk.	Payne	1922
" 35C	3 wk.	"	"
" 27C	> 9 wk.	"	"
" 15C	10-12 wk.	"	"
" 0C	1 wk.	"	"
" direct sun	5 d.	"	"
"	42-84 d.	Yoshida	1920
Larva in soil and feces, direct sun, no veg.	Inoc. 150, Recov. 0, 6 wk.	Augustine	1923
Larva in soil and feces, direct sun with veg.	Inoc. 4,208, Recov. 32, 6 wk.	"	"
Larva in soil and feces, direct sun with veg.	Inoc. 8,160, " 0, 9 wk.	"	"
Larva in soil and faces, bright shade, no veg.	Inoc. 98,160, Recov. 16,044; 5½ wk.	"	"
Larva in soil and feces, bright shade, no veg.	Inoc. 105,600, Recov. 0, 10 wk. & 2 d.	"	"
Larva in soil and feces, light shade, with veg.	Inoc. 30,960, Recov. 12,240; 6 wk.	"	"
Larva in soil and feces, light shade, with veg.	Inoc. 36,592, Recov. 60, 9½ wk.	"	"
Larva in soil and feces, dense shade, no veg.	Inoc. 9,680; Recov. 2420, 5 wk. & 3 d.	"	"

TABLE 210 (CONT'D) THE SURVIVAL OF PROTOZOA AND METAZOA IN SOIL

Factor(s)	Survival	Reference	
GENERAL (cont'd)			
Necator americanus			
Larva in soil and feces, dense shade, no veg.	Inoc. 48,168; Recov. 0, 9 wk.	Augustine	1923
Larva in soil and feces, dense shade, with veg.	Inoc. 190,120; Recov. 104,360; 5 wk. & 5 d.	"	"
Larva in soil and feces, dense shade, with veg.	Inoc. 99,680; Recov. 540, 9 wk. & 2 d.	"	"
Soil and feces dil. with water in spring	99%reduc., 8-12 wk.	Cort	1925
Soil and feces dil. with water, summer, 70F	99% reduc., 4-6 wk.	"	"
Soil and feces dil. with urine, summer	99% reduc., 2-3 wk.	"	"
Eimeria tenella			
Oocysts of E. tenella in soil, direct sunlight	< 1 yr.	Farr	1949
Oocysts of E. tenella in soil, part shade	" " "	"	"
Oocysts in soil, deep shade	" " "	"	"
Addition of 10% CaO to contaminated soil	Org. still present 12 wk.	Patterson	1933
Eimeria maxima			
Oocysts in soil, direct sun	< 1 yr.	Farr	1949
Oocysts in soil, part shade	" " "	"	"
Oocysts in soil, deep shade	" " "	"	"
Eimeria acervulina			
Oocysts in soil	86 wk.	"	"
Gastrointestinal Nematodes of sheep			
Pasture soil, temp. warm and moist	Good survival	Kates	1950
Pasture soil, cold weather	Highly resistance	"	"
Pasture soil, drought and high temp.	Low "	"	"
Pasture soil, free living stages, drought high & low temp.	Most resistant to complex climatic conditio[n]	"	"
Pasture soil, larva of most common parasites	3-3.5 mo.	"	"
1 gm. of field soil	Numerous	Waksman	1927
Toxocara canis			
Soil under snow	Winter mo.	Owen	1930

TABLE 5 11 THE SURVIVAL OF SALMONELLA SPECIES IN SOIL

Factor(s)	Survival	Reference	
CLAY			
S. typhosa			
.Clay, rainy season	6 wk.	Beard	1937
" dry "	3 "	"	"
"	15 d.	Levy	1903
HUMUS AND GRAVEL			
S. typhosa			
Humus and gravel, RT.	Inoc. 24 hr. bouillon cult., 9-16 mo.	Rullmann	1901
LOAM			
S. typhosa			
Loam	49 d.	Beard	1940
" , rain	120 d.	"	"
Sandy loam with raw sewage	Recov. 0, 5 d.	Mallmann	1951
Clayloam	" " 12 d.	"	"
MUD			
S. typhosa			
Mud at bottom of aquarium	2 mo.	Hoffmann	1926
Tidal mud	5 wk.	Savage	1905
S. typhimurium			
Mud in infected water, outside temp.	Demonstrable 22 d.	Bartos	1947
PEAT			
S. typhosa			
Stock cult. and dry peat, at 51F. max. 56F and min. 37F	>13 d.	Firth	1902
S. spp.			
Peat, pH 3-4	Low survival	Beard	1940
Peat	24 hr.	Dempster	1894
" , dry or wet or moist	20-30 d.	Hanne	1932
Pure peat	24 hr.	Martin	1898
Peat with sewage, 52-78F	11 d.	Firth	1902
SAND			
S. typhosa			
Fine sand with dil. raw sewage, 33F-54F	Inoc. stock cult., 6 d.	Firth	1902
Fine sand with dil. raw sewage, 55F-75F	" enteric stool cult. 13 d.	"	"
Sand	4-7 d.	Beard	1940
Dry sand, 53-83F	>25 d.	Firth	1902
Fine sand, moist	>12 d.	"	"
White sand	70 d.	Dempster	1894
Sand with sewage	Recov. 1.336, 33 d.	Mallmann	1951
Ster. sand	55 d.	Murillo	1919
Filtered sand	82 d.	Osler	1901
Ster. sand, filtered, 140C air dried after 36 hr. 4 min. water susp'n	Viable 82 d.	Uffelmann	1894
GENERAL			
S. typhosa			
Soil, freezing temp	<12 mo.	Beard	1940

TABLE 5// (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN SOIL

Factor(s)	Survival	Reference	
GENERAL			
S. typhosa			
Soil moistened with sewage, 33.2-83F	Inoc. Stock cult., 74 d.	Firth	1902
Soil around drain moistened with sewage, 14.3-58.8F	" " " 65 d.	"	"
Soil around leaking drain moistened with sewage, 40-81F	" Stool cult., 53 d.	"	"
Soil with sewage kept in a closed box, 19.6-59.2F	" " " 45 d.	"	"
Stool of carrier mixed with garden soil	< 7 d.	Horrocks	1911
Ster. feces, infected soil R.T.	Inoc, 1 cc 24 hr. bouillon cult., Viable 1 yr.	Rullmann	1901
Unster. feces, infected soil, R.T.	Inoc. 1cc 24 hr. bouillon cult., Viable 100d.	"	"
Soil	50% in 48 hr.	Beard	1940
Moist soil, freezing temp.	24 mo.	"	"
" " " and refreezing	99% reduc. in 18 mo.	"	"
Moist soil with rain added, 16.2-57F	55 d.	Firth	1902
Soil and rain, 14.8-54.3F	44 d.	"	"
" " " 34-62F	32 d.	"	"
Surface soil, 122 hr. sunshine	22 d.	"	"
Soil	5½ mo.	Grancher	1889
Garden earth	10-21 d.	Dempster	1894
Natural soil	3 mo.	Karlinski	1889
Soil, dry	12-30 d.	Kligler	1921
" wet	40-90 d.	"	"
Unster. soil	42-74 d.	Mair	1908
Ster. "	9 d.	"	"
Natural soil	Small no. 70-80 d.	"	"
" "	Large " 20 d.	"	"
Soil enclosed by grass & moisture added	84 d.	"	"
Garden soil	>36 d.	Murillo	1919
Soil, freezing temp.	Decreases viability	Robertson	1898
"	Low temp, moisture, inc. viability	Rudolfs	1950
" , unster.	>100 d.	Rullmann	1901
Polluted soil, ster.	>16 mo.	"	"
Garden earth	21 d.	Osler	1901
Ster. soil	Inoc. broth cult., 216 d.	Rullmann	1901
Soil filtrate, dark	Inoc. 7000/ml., Recov. 1100/ml., 5 d.	Ruys	1941
Dry soil	>2 wk.	Sedgwick	1902
Natural soil	21 d.	Smith	1903
Dry soil	8 d.	Tanner	1944
Moist soil	>60 d.	"	"

TABLE 511 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN SOIL

Factor(s)	Survival	Reference	
GENERAL			
S. typhosa			
Ster. garden soil, 140C, air dried after wetting with susp'n of typhosa	Viable 21 d.	Uffelmann	1894
Upper soil layers	6 mo.	McFarland	
Soil natural or ster.	Short time	Smith	1904
" with carrier urine, allowed to dry at lab. temp.	Inoc. 12000/gm, Recov. 330/gm, 7 d.	Horrocks	1911
Humus from garden soil with carrier urine, exposed to weather without rain	Inoc. 1600/gm, Recov. 280/gm, 10 d.	"	"
Soil	Found on veg in soil	Melick	1917
S. paratyphi A & B			
Dry soil	8 d.	Tanner	1944
Moist soil	> 60 d.	"	"
S. enteritidis			
Soil	Short time	Smith	1904
S. pullorum			
Soil, pH 7.0	> 64 d.	Sanyal	1941
S. gallinarum			
Soil, pH 6.2-6.4	1 wk.	Sanyal	1941
" " 6.7-7.0	40-70 d.	"	"
S. spp.			
Tomatoes grown on fertilized soil	< 7 d.	Falk	1949
Soil and feces (enteric stool) 38-79F	53 d.	Firth	1902
Damp soil with raw sewage	35 d.	"	"
Moss	404 d.	Martin	1898
Ster. soil	Death more rapid	"	"
Dry soil	Inoc. agar & 3 drops feces susp'n, Viable 28 d.	Pfuhl	1902
Wet garden earth, 1½-21C	Inoc. agar and feces, viable 3 mo.	"	"
Soil from 1 summer to another	Sunlight kills org. on surf. < 1/10 inch deep still alive	Robertson	1898
Tomatoes growing in field fecal matter applied	7 d.	Rudolfs	1951

TABLE ___

THE SURVIVAL OF SHIGELLA SPECIES IN SOIL

Factor(s)	Survival	Reference	
SAND			
S. dysenteriae			
Sand, heated room	Viable 12 d.	Pfuhl	1902
GENERAL			
S. dysenteriae			
Feces and earth, 1.5-15C	>101 d.	Hampil	1932
Earth and water, 5-6C	Growth inhibited	Hampil	1932
Dry soil	12-30 d.	Kligler	1921
Wet "	40-90 d.	"	"
Wet garden earth, 1½-21C	Viable 101 d.	Pfuhl	1902
Feces applied to tomatoes growing in field	7 d.	Rudolfs	1951
Garden soil	6-49 d.	Vincent	1917
Soil	6-15 d.	Zinsser	1939
Rich garden soil	No survival time	Felsen	1945
S. paradysenteriae (Flexner)			
Series of trenches at 1,2, 3, 4, 5, & 6 ft. levels	Inoc. 25 cc. 10 day broth cult., < 1 yr.	"	"
Rich garden soil	No survival time	"	"

TABLE 513 THE SURVIVAL OF STREPTOCOCCUS SPECIES IN SOIL

Factor(s)	Survival	Refernece	
LOAM			
S. faecalis			
Loam	Recov. 6.4 logs/100gm., 0 wk.	Mallmann	1951
"	Recov. 0.7 " " " 11 wk.	"	"
S. spp.			
Loam (Isabella)	Inoc. 5.9 logs/100gm., Recov. 0.8 logs/100 gm., 9 wk.	"	"
" (Fox Sandy)	Inoc. 5.2 logs/100 gm., Recov. 2 logs/100 gm., 5 wk.	"	"
" (Brookston clay)	Inoc. 5.6 logs/100 gm., Recov. 0.8 logs/100 gm., 7 wk.	"	"
Muck	Inoc. 5.9 logs/100 gm., Recov. 0.6 logs/100 gm., 11 wk.	"	"
Dried Miami sandy loam, 1 treatment raw sewage & S. typhosa	Inoc. 5.5 logs/100gm., Recov. 3.7 logs/100gm., 26 d.	"	"
Dried Brookston clay loam, 1 treatment raw sewage & S. typhosa	Inoc. 5.7 logs/100 gm., Recov. 2.9 logs/100gm, 33 d.	"	"
Dried muck, 1 treatment raw sewage & S. typhosa	Inoc. 7.0 logs/100 gm., Recov. 1.4 lgos/100gm., 40 d.	"	"
SAND			
S. pyogenes			
Sand	53 d.	Laurell	1949
S. spp.			
10 gm. of sand	Inoc. 2cc. broth cult., 66 d.	Bryan	1934
" " " "	Inoc. 2cc. nutrient susp. 66 d.	"	"
Oshtemo sand	Inoc. 4.6 logs/100 gm., 5 wk.-0.9 " " "	Mallmann	1951
Dried Oshtemo sand, 1 treatment of sewage & S. typhosa	Inoc. 5.0 logs/100 gm., Recov. 1.3 logs/loo gm. 33 d.	"	"
GENERAL			
S. faecalis			
Soil	Found	Winter	1946
S. pyogenes			
Soil, R. T.	53 d.	Laurell	1949
S. spp.			
Soil fertilized with chicken manure, 72C	Inoc. 10^{-2}, Recov. 10^{-1} dil/g., 21 d.	Ostrolenk	1947
Soil fertilized with chicken manure, R.T.	Inoc. 10^{-5}, Recov. 10^{-2} dil/g., 160 d.	"	"

TABLE 5/3 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES IN SOIL

Factor(s)	Survival	Reference	
GENERAL (cont'd)			
S. spp.			
10 gm. soil	Inoc. 2cc. broth cult., 12 d.	Bryan	1934
10 gm. soil	Inoc. 2cc. nutrient free susp'n, 10 d.	"	"
Unster. soil, R.T.	Inoc. 10^{-1}, Recov. 1 gm, 109 d.	Ostrolenk	1947
Unster. " ice box	Inoc. 10^{-1}, Recov. 10^{-2}, 123 d.	"	"
Soil with pecans artif. infect.	Inoc. 10^{-4}, Recov. 10^{-1}, 160 d.	"	"

TABLE 514 THE SURVIVAL OF VIRUSES IN SOIL

Factor(s)	Survival	Reference
SAND		
Foot & mouth virus		
Sand, 62F, R.H. 52%	14 d.	Burbury 1928
GENERAL		
Newcastle virus		
Soil, 37C, pH 5.2	Inoc. 1 ml., 25 d.	Olesuik 1951
" 20-30C, pH 4.9	" " " 71 d.	" "
" 11-36C, pH 4.9	" " " 172 d.	" "
" 3-6C, pH 4.9	" " " 235 d.	" "
" -26C, " "	" " " 538 d.	" "
Soil in chicken pens	1 mo.	Levine 1950
Bacteriophage		
S. typhosa phage in soil 3 ft. deep	Present	Pasricha 1941

References (Soil)

1. Albrecht, W.A., and Turk, L.M. 1930 Legume bacteria with reference to light and longevity. Mo. Agr. Exp. Sta., Research Bull., 132, 3-19.
2. Augustine, D.L. 1922 Experiments on length of life of infective hookworm larvae in soils. Am. J. Hyg., 2, 177.
3. Augustine, D.L. 1923 Experiments on the factors determining the length of life of infective hookworm larvae. Am. J. Hyg., 3, 420-443.
4. Bang, B. 1897 Die Aetiologie des seuchenhaften (infectiosen) Verwerfens. Z. Thier., 1, 241-278.
5. Barthel, C. 1924 Length of life of lactic acid bacteria in chalked milk and in soil cultures. Kgl. Landtbruks-Akad. Handl. Tid., 63, 642-650.
6. Bartos, D., Bansagi, J. and Bakos, K. 1947 Die Lebensdauer der enteralen Krankheitserregenden Bakterien im Brunnenwasser. Z. Hyg. Infektionskrankh., 127, 347-354.
7. Beard, P.J., Carlson, J.M., and Chambers, R.D. 1937 The survival of Eberthella typhosa in soil. J. Bact., 33, 74.
8. Beard, P.J. 1940 Longevity of Eberthella typhosus in various soils. Am. J. Pub. Health, 30, 1077.
9. Beaver, P.C. and Deschamps, G. 1949 The viability of E. histolytica cysts in soil. Am. J. Trop. Med., 29, 189-191.
10. Beranek, J. 1948 Studie zivotnosti anthraxovych spor na rostlinstvu zamorene pudy. Casopis Ceskoslov. Vet., 3, 557-563.
11. Bokor, R. 1926 Microflora of forest soils. Botan. Inst. Kon. Ung. Hochschule Berg. u. Forstingen Forstl. Vers., Sopron, 28.
12. Brown, H.W. 1927 Studies on the rate of development and viability of the eggs of Ascaris lumbricoides and Trichuris trichiura under field conditions. J. Parasitol., 14, 1-15.
13. Bryan, C.S. 1934 The viability of streptococci of mastitis. Vet. Med., 29, 524-526.
14. Bryan, C.S. 1935 Influence of controlled temperature and soil treatment on some soil bacteria. Michigan Agr. Exp. Sta., Quart. Bull., 18, 106-113.
15. Buchanan, G. 1927 Spec. Rep. Ser., Med. Res. Counc., London, No. 113.
16. Cameron, H.S. 1932 The viability of Brucella abortus. Cornell Vet., 22, 212-224.
17. Chick, H. 1900-1901 The distribution of Bacterium coli commune. Thompson Yates Lab. Rep., 3, 1-29, 117-129.
18. Christiansen, M.J. 1950 Graesmarksinfektion og kvaegbrucellose. Kastningsbakteriers levedygtighed i det fri, belyst ved praktiske forsøg. Maanedsskr. Dyrlaeger, 61, 253-288.
19. Ciferri, R. 1949 Contro interpretazioni finalistiche degli antibiotici: saggi negativi di accertamento diretto dell' esistenza di antibiotici nel suolo. Atti Ist. Bot. Univ. Lab. Crittogamico Pavia, 3, 274-276.
20. Cort, W.W. 1925 Investigations on the control of hookworm disease. XXXIV. Am. J. Hyg., 5, 49.
21. Curran, H.R. 1935 The influence of some environmental factors upon the thermal resistance of bacterial spores. J. Infectious Diseases, 56, 196-202.

22. Damon, S.R., and Payabi, L.B. 1926 Distribution of spores of B. botulinus and B. tetani in soil, in Maryland. J. Infectious Diseases, 39, 491-501.
23. Demoussy, E. 1929 Resistance of soil microorganisms to the low temperature obtaining (in France) during 1928 to 1929. Ann. Sci. Agron., 46, 395-399.
24. Demsptеr, R. 1894 The influence of different kinds of soil on the Comma and typhoid organisms. Brit. Med. J., 1, 1126.
25. Dhar, N.R., and Seshacharyulu, E.V. 1939 New aspects of nitrogen fixation and conservation in the soil. III. Influence of light on bacterial numbers and nitrogen fixation. J. Indian Chem. Soc., 16, 463-476.
26. Dubovsky, B.J., and Meyer, K.F. 1922 The occurrence of B. tetani in soil and on vegetables. J. Infectious Diseases, 31, 614-616.
27. Eggleton, W.G.E. 1934 Studies on the microbiology of grassland soil. I. General chemical and microbiological features. J. Agr. Sci., 24, 416-434.
28. Falk, L.L. 1949 Bacterial contamination of tomatoes grown in polluted soil. Am. J. Pub. Health, 39, 1338-1342.
29. Farr, M.M., and Wehr, E.E. 1949 Survival of Eimeria acervulina, E. tenella and E. maxima oocysts on soil under various field conditions. Ann. New York Acad. Sci., 52, 468-472.
30. Feher, D. 1930 Untersuchungen über die Kohlenstoffernährung des Waldes. Verhandl. Internat. Kongr. Versuchsanst, 1929, 546-556.
31. Feher, D. 1938 Untersuchungen über die biodynamischen Grunlagen der Bodenatmung. Z. Forstu. Jagdwesen, 70, 65-89.
32. Fellow, C.C., and Fellow, M.G. 1923 Observations on the viability of the Bacterium coli group under natural and artificial conditions. Am. J. Pub. Health, 13, 270-273.
33. Firth, R.H. 1902 On the viability of the enteric bacillus in soil and sewage, and its bearing upon some methods of sewage disposal. J. San. Inst., London, 23, 614-619.
34. Firth, R.H., and Horrocks, W.H. 1902 An inquiry into the influence of soil, fabrics, and flies in the dissemination of enteric infection. Brit. Med. J., 2, 936-943.
35. Foraker, A.G. 1941 Survey of tetanus in soil of Key West, Florida. Military Surgeon, 89, 747-750.
36. Germano, E. 1897 Die Uebertragung von Infektionskrankheiten durch die Luft. II. Mittheilung-Die Uebertragung der Diphtherie Durch die Luft. Z. Hyg. Infektionskrankh., 25, 439-452.
37. Grancher, J., and Deschamps, E. 1889 Arch. Med. Exper. et D'Anat. Path., 1, 33.
38. Greaves, J.E., and Jones, L.W. 1944 The influence of temperature on the microflora of the soil. Soil Sci., 58, 377-387.
39. Grushevoi, S.E., Levykh, P.M., and Macbieva, E.I. 1940 Disinfecting seed-bed soil with the heat from the sun. Vsesoyuz. Nauch.-Issledovatec. Inst. Tabach. i Makhoroch. Prom., 141, 49-61.
40. Haines, R.B. 1942 Occurrence of Clostridium botulinum in English soils. J. Hyg., 42, 323-327.
41. Hall, N.M., and Clegg, L.F. 1950 Microbiological aspects of the partial sterilization of soil by chemicals. A review of the literature. Proc. Soc. Applied Bact., 1949, 105-118.

42. Hampil, B. 1932 The influence of temperature on the life processes and death of bacteria. Quart. Rev. Biol., 7, 172-196.
43. Hanne, R. 1932 Die Verwendung des Torfes vom bakteriologischen Standpunkt aus betrachtes. Z. Geshundheitstech. Städtehyg., 24, 127-134.
44. Heeger, E.F. 1949 Fertilizing of medicinal and aromatic herbs and of vegetables with human feces, a source of worm infection. Pharmazie, 4, 192-193.
45. Heiser, V.G. 1917 Soil pollution problem. New York State J. Med., 17, 298.
46. Hoffmann, E. 1926 On syphilitic infection with material from dead bodies and possible parasitic life of Spirochaeta pallida. Munch. Med. Wochnschr., 73, 185-187.
47. Horrocks, W.H. 1903 J. Roy. Army Med. Corps, 1, 362.
48. Horrocks, W.H. 1906 Report of Commission on Mediterranean Fever (On the duration of life of M. melitensis in unsterilized soil. Harrison and Sons, London.
49. Horrocks, W.H. 1911 On the viability and possible variation of the Bacillus typhosus. J. Roy. Army Med. Corps, London, 16, 225-250.
50. Houston, A.C. 1897-1902. Rep. Med. Officer, Local Govt.
51. Ishihara, N., and Murakami, K. 1933 Distribution of tetanus bacilli in earth of gymnasium grounds of Taihoku schools. Taiwan Igakki Zasshi, 32, 113.
52. Jensen, H.L. 1930 Actinomycetes in Danish soils. Soil Science, 30, 59-77.
53. Jordan, E.O. 1926 The changes in the bacterial content of stored normal and typhoid feces. J. Infectious Diseases, 38, 306-322.
54. Kanivets, M.I., and Lebedeva, M.A. 1938 The increase in the productivity of the soil under the influence of a system of cultivation. Nauch. Zapiski Sakharnoi Prom. Agron. Byp. 15, 161-176.
55. Karlinski, J.R. 1889 Centr. Bakt., 65.
56. Kates, K.C. 1950 Survival on pasture of free-living stages of some common gastrointestinal nematodes of sheep. Proc. Helminthol. Soc. Washington, 17, 39-58.
57. Kathe, J. 1945 Witterungsverhältnisse unde Mäuse in ihrer Bedeutung für die Epidemiologie des Schlamm oder Feldfiebers. Zentr. Bakt. I. Abt. Orig., 151, 481-489.
58. Katznelson, H. 1940 Survival of Azotobacter in soil. Soil Science, 49, 21-35.
59. Katznelson, H. 1940 Survival of microorganisms inoculated into sterilized soil. Soil Science, 49, 211-217.
60. Katznelson, H. 1940 Survival of microorganisms introduced into soil. Soil Science, 49, 283-293.
61. Klein, E.K. 1935 Constancy of characteristics differentiating intermediates in the Escherichia-Aerobacter group and their interpretation. Am. J. Pub. Health, 25, 833-838.
62. Kligler, I.J. 1921 Investigations of soil pollution and the relation of various types of privies to the spread of intestinal infections. Intern. Health Bd., Monograph Rockefeller Inst. Med. Research, No. 15, 1-75.

63. Koser, S.A. 1924 Is ability to utilize citrate readily acquired or lost by the colon-aerogenes group. J. Infectious Diseases, 35, 315-322.
64. Kulp, W.L. 1932 A note concerning the effect of a specific environ on the character and viability of several strains of A. aerogenes and E. coli. J. Bact., 24, 317-320.
65. Laubach, C.A., and Rice, J.L. 1916 Spore-bearing bacteria in soil. J. Bact., 1, 513.
66. Laurell, G., Lofstrom, G., Magnusson, J.M., and Ouchterlony, O. 1949 Airborne infections. II. A report on the methods. Acta. Med. Scand., 134, 189-204.
67. Levine, P.P., Fabricant, J., Gillespie, J.H., Angstrom, C.I., and Mitchell, G.B. 1950 The results of pen contact exposure of susceptible chickens to chickens recovered from Newcastle disease. Cornell Vet., 40, 206-210.
68. Levy, E., and Kayser, H. 1903 Uber die Lebensdauer von Typhusbacillen, die im Stuhle entleert wurden. Centr. Bakt. I. Abt., 33, 489-495.
69. Lieske, R., and Hofmann, E. 1929 Untersuchungen über den Bakteriengehalt der Erde in groben Tiefen. Centr. Bakt., 77, 305-309.
70. Lochhead, A.G. 1925 The bacterial types occurring in frozen soil. Soil Science, 21, 225-231.
71. Loesener, W. 1896 Uber das Verhalten von pathogenen Bakterien in Beerdigten Kadavern und über die dem Erdreich und Grundwasser von solchen Gräbern Angeblich drohenden Gefahgen. Arb. A.D. Kais. Gesund., 12, 448-539.
72. Lovell, R., Levi, M., and Francis, J. 1944 Studies on the survival of Johne's bacilli. J. Comp. Path. Therap., 54, 120-129.
73. McClellan, W.D., Cristie, J.R., and Horn, N.L. 1949 Efficacy of soil fumigants as affected by soil temperature and moisture. Phytopathology, 39, 272-283.
74. McFarland, N.I. Text on Pathogenic Bacteria.
75. Maddock, E.C.G. 1933 Studies on the survival time of the bovine tubercle bacillus in soil, soil and dung, in dung and on grass with experiments on preliminary treatment of infected organic matter and the culture of the organism. J. Hyg., 33, 103-117.
76. Maddock, E.C.G. 1934 Further studies on survival time of bovine bacillus in soil, soil and dung, in dung and on grass. J. Hyg., 34, 372-379.
77. Mair, W. 1908 Experiments on the survival of B. typhosus in sterilized and unsterilized soil. J. Hyg., 8, 37.
78. Mallmann, W.L., and Litsky, W. 1951 Survival of selected enteric organisms in various types of soil. Am. J. Pub. Health, 41, 38-44.
79. Martin, S. 1896-1897 Supp. to Rep. of Med. Off. Local Gov't Bd.
80. Martin, S. 1898 Rep. Med. Off., Local Gov't. Bd.
81. Melick, C.O. 1917 The possibility of typhoid infection through vegetables. J. Infectious Diseases, 21, 28-38.
82. Minett, F.C. 1950 Sporulation and viability of B. anthracis in relation to environmental temperature and humidity. J. Comp. Path. Therap., 60, 161-176.

83. Murillo, F. 1919 Plus-Ultra, Madrid, 2, 115.
84. Musehold, P. 1900 Uber die Widerstandsfähigkeit der mit dem Lungenauswurf herausbeförderten Tuberkelbazillen in Abwassern, im Flusswasser und im kultivirten Boden. Arb. A.D. Kaiserlich Ges., 17, 56-107.
85. Novogroudsky, D.M. 1948 Ob odnom proiavlenii antimikrobnyck svoistv pochvy. Mikrobiologiia, 17, 193-200.
86. Olesiuk, O.M. 1951 Influence of environmental factors on viability of Newcastle disease virus. Am. J. Vet. Research, 12, 152-155.
87. Osler, W. 1901 Practice of Medicine (4th Ed.).
88. Ostrolenk, M., Kramer, N., and Cleverdon, R.C. 1947 Comparative studies of enterococci and Escherichia coli as indices of pollution. J. Bact., 53, 197.
89. Otte, G.F. 1929 A study of the moisture requirements of the eggs of the horse, the dog, human and pig ascarids. Am. J. Hyg., 10, 497-520.
90. Ouchterlony, O. 1949 Airborne infections. III. Infections and spreading of infection in diphtheria with special reference to isolation wards. Acta. Med. Scand., 134, 296-309.
91. Owen, W.D. 1930 Factors that influence the development and survival of the ova of an ascarid roundworm Toxocara canis under field conditions. Tech. Bull. No. 71, Univ. Minn. Agric. Exp. Sta.
92. Owen, W.L., and Mobley, R.L. 1948 A new species of Torulae occurring in and transmitted by the American cockroach Periplaneta americana (Linn). Food, Research, 13, 281-290.
93. Parry, E.W. 1946 Prevalence of Clostridium botulinus in soils of central New York State. Food Research, 11, 203-209.
94. Pasricha, C.L., and Paul, B.M. 1941 Bacteriophages in soil. Indian Med. Gaz., 76, 416.
95. Pasteur, L. 1881 Compt. rend. acad. Sci., 92, 209.
96. Patel, M.K. 1929 Viability of certain plant pathogens in the soil. Phytopathology, 19, 295-300.
97. Patterson, F.D. 1933 Studies on the viability of Eimeria tenella in soil. Cornell Vet., 23, 232-249.
98. Payne, F.K. 1922 Investigations on the control of hookworm disease. XI. Vertical migration of infective hookworm larvae in the soil. Am. J. Hyg., 2, 254-263.
99. Pfuhl, E. 1902 Vergleichende Untersuchungen über die Haltbarkeit der Ruhr bacillen und der Typhus bacillen auberhalt des menschlichen Körpers. Z. Hyg. Infektionskrankh., 40, 555-566.
100. Pramer, D., and Heukelekian, H. 1950 The survival of tubercle bacilli in sewage treatment processes. Sewage and Indust. Wastes, 22, 1123-1125.
101. Previtero, A. 1945 Sulla variazione dell'Escherichia coli nel terreno. Atti R. Accad. Fisiocrit. Siena, Sez. Med.-Fis., 13, 57, 118-123.
102. Remlingen, P., and Nouri, O. 1909 Les microbes pathogenes du sol peuvent-ils penetrer a l'interieur des vegetaux.
103. Rhines, C. 1935 Persistence of avian tubercle bacilli in soil and in association with soil microorganisms. J. Bact., 29, 299-311.

104. Robertson, J. 1898 Soil as a factor in the spread of certain diseases. Brit. Med. J., 1, 421-424.
105. Robertson, J. 1898 Notes on an experimental investigation into the growth of B. typhosus in soil. Brit. Med. J., 1, 69-71.
106. Rossi, G. 1931 New acquisitions in general bacteriology derived from bacteriology of soil. Ann. d'ig., 41, 233-252.
107. Rubenchik, L.I., and Khaim, S.Z. 1935 The survival of estuary mud microbes. Microbiology, 4, 660-668.
108. Rubentschik, L., Roison, M.B., and Bieljamsky, E.M. 1936 Adsorption of bacteria in Salt Lakes. J. Bact., 32, 11-31.
109. Rudolfs, W., Falk, L., and Ragotzkie, R. 1950 Literature review on the occurrence and survival of enteric, pathogenic, and related organisms in soil, water, sewage and sludges and on vegetation. I. Bacterial and virus diseases. Sewage and Indust. Wastes, 22, 1261-1281.
110. Rudolfs, W.L., Falk, L., and Ragotzkie, R.A. 1950 Literature review on the occurrence and survival of enteric, pathogenic, and related organisms in soil, water, sewage, and sludges and on vegetation. II. Animal parasites. Sewage and Indust. Wastes, 22, 1417-1427.
111. Rudolfs, W., Falk, L.L., and Ragotzkie, R.A. 1951 Contamination of vegetables grown in polluted soil. Sewage and Indust. Wastes, 23, 253-268.
112. Rudolfs, W., Falk, L., and Ragotzkie, R. 1951 Contamination of vegetables grown in polluted soil. IV. Bacterial decontamination. Sewage and Indust. Wastes, 23, 739-751.
113. Rullmann, W. 1901 Ueber einen in Erde und Fehlböden Uorkommenden sporenbildenden Bacillus. Centr. Bakt. Parasitenk., I, Abt., 29, 969-972.
114. Rullmann, W. 1901 Über das Verhalten des Erdboden eingesäten Typhus bacillus. Centr. Bakt., I, Abt. (Orig.), 30, 321-335.
115. Sanyal, S.N. 1941 The role of the soil in its relation to the microorganisms causing animal diseases. Calcutta Med. J., 38, 305-308.
116. Savage, N.I. 1903-1904. J. Sanit. Inst., 24, 442.
117. Savage, W.G. 1905 Bacteriological examination of tidal mud as an index of pollution of the river. J. Hyg., 5, 146-174.
118. Schalk, A.F. 1928 Results of some avian tuberculosis studies. J. Am. Vet. Med. Assoc., 72, 852-864.
119. Sedgwick, W.T., and Winslow, C.E.A. 1902 Mem. Am. Acad. Arts and Sci., 12, 508.
120. Sharp, G. 1896 The soil in relation to diphtheria and its organism. Brit. Med. J., 2, 442-444.
121. Sirena, S., and Scagliosi, G. 1894 Riforma Med., 2, 340.
122. Sirena, S., and Scagliosi, G. 1895 Durata in vita del bacillo del carboncaio nel terreno nell' Acquapotabile, in quella di mare e nel materiale di fogna. Centr. Bakt., Abt. I, 17, 318-319.
123. Skinner, C.E., and Murray, T.J. 1926 The viability of B. coli and B. aerogenes in soil. J. Infectious Diseases, 38, 37-41.

124. Slack, H.D. 1937 Notes on the viability of Bacillus salmonicida Emmerich and Weibel. Ann. Appl. Biol., 24, 665-672.
125. Smith, L. 1903 Report on the occurrence of typhoid fever in Belfast. Mair, W. 1908 J. Hyg., 8, 37.
126. Smith, J.L. 1904 An investigation into the conditions affecting the occurrence of typhoid fever in Belfast. J. Hyg., 4, 407-433.
127. Solowey, M., Solotorovsky, M., and Buchbinder, L. 1942 Vll. Further observations on the survival rates of streptococci and pneumococci in daylight and darkness. J. Bact., 43, 545-555.
128. Steinhaus, E. A., and Kohls, G.M. 1945 Tularemia in beavers and muskrats and the contamination of natural water and mud with Pasteurella tularensis in the northwestern United States. J. Bact., 45, 56-67.
129. Tanner, F. W. 1944 The microbiology of foods. Garrard Press, Champaign, Ill., 2nd Ed.
130. Uffelmann, J. 1894 Versuch über die Widerstandsfähigkeit der Typhusbacillen gegen Trocknung und über die Möglichkeit ihrer Verschleppung durch die Luft. Centr. Bakt. I Abt. (Orig.), 15, 133-140.
131. Vandecaveye, S.C. 1927 Effect of moisture, temperature, and other climatic conditions on R. Leguminosarum in the soil. Soil Science, 23, 355-362.
132. Vandecaveye, S.C., and Anderson, S. 1934 Longevity of Azotobacter in soils treated with lime and superphosphate. J. Am. Soc. Agron, 26, 353-364.
133. Vincent, J.H., and Muratet, L.M. 1917 Les dysenteries. les cholera Asiatique, le typhus exanthematizue. Masson et Cie, Paris.
134. Waksman, S.A. 1927 Soil microbe. Sci. Monthly, 25, 40-45.
135. Waksman, S.A. 1940 Soil Microbiology. Ann Rev. Biochem., 9, 509-528.
136. Waksman, S.A., and Woodruff, H.B. 1940 Survival of bacteria added to soil and the resultant modification to soil population. Soil Sci., 50, 421-427.
137. Wencke, N.I. 1900 Berlin Arch. Thierheilk, 26, 327.
138. Williams, R.S., and Hoy, W.A. 1930 Viability of B. tuberculosis (Bovinius) on pasture land, in stored feces, and in liquid manure. J. Hyg., 30, 413-419.
139. Winfield, G.F., and Chin, T. 1939 Studies on the control of fecal-borne diseases in North China. Vlll. The epidemiology of the parasitic amoebae. Chinese Med. J., 56, 265.
140. Winslow, C.E.A., and Abramson, F. 1911-1912. The effect of drying upon the viability of bacteria. Proc. Soc. Exp. Biol. and Med., 9, 107.
141. Winter, C.E., and Sandholzer, L.A. 1946 Studies of the fecal streptococci. I. The isolation of enterococci from natural sources. Fish. Leaflet, 201, 1-6.
142. Yoshida, S. 1920 On the resistance of ascaris eggs. J. Parasitol., 6, 132-139.
143. Young, C.C., and Greenfield, M. 1923 Observations on viability of B. Coli group under natural and artificial conditions. Am. J. Pub. Health, 13, 270-273.

144. Zinsser, H., and Bayne-Jones, S. 1939 Textbook of Bacteriology. 8th Ed., Appleton-Century, New York.
145. ZoBell, C.E. 1942 Microorganisms in marine air. Aerobiology, No. 17, 55-68.
146. ZoBell, C.E., and Conn, J.E. 1940 Studies on the thermal sensitivity of marine bacteria. J. Bact., 40, 223-238.

References (Soil) Addendum

1a. Briscoe, L.F. 1912 Fate of tubercle bacilli outside the animal body. Ill. Agr. Exp. Sta. Bull., No. 161.

2a. Burbury, Y.M. 1928 Survival of the foot-and-mouth disease virus outside the body. Ann. Appl. Biol., 15, 139-142.

3a. Felsen, J. 1945 Dysentery , colitis, and enteritis. W.B. Saunders Co., Philadelphia.

4a. Galtier, V. 1887 Dangers des motieres tuberculeuses qui ont subi la dessication le contact prolonge de L'eau etc. Compt. Rend. de Acad. de Sci., 105 , 231.

5a. Lipman, C.B. 1931 Living microorganisms in ancient rock. J. Bact., 22, 183-198.

6a. Noguchi, H. 1918 Survival of *Leptospira icterohaemorrhagiae* in nature; microchemical reactions and intermediary hosts. J. Exp. Med., 27, 609.

7a. Parker, R.R., Steinhaus, E.A., Kohls, Glen 1943 Tularemia in beavers and muskrats and the contamination of natural waters and mud by Pasteurella tularensis in the northwestern United States. J. Bact., 45, 56-57.

8a. Ruys, A.C. 1941 On the behavior of *E. typhi* in surface water. J. Microbiol. Serol., 7, 93-103.

9a. Topley, W. and Wilson G. 1946 Principles of bacteriology and immunity. The Williams and Wilkins Co. , Baltimore.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS ON SURFACES

TABLE 41 THE SURVIVAL OF BACILLUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
B. megatherium			
Evidence of transport of spores during dust storm	----------------	Soule	1934
FABRIC			
B. anthracis			
Silk threads, spores	>20 hrs.		
" " , non-spores.	Dead in few hrs.	Ficker	1898
Dry sterile canvas, room temp., diffuse sunlight, dry atm., spores.	>10-22 1/2 yrs.	Graham	1941
Dry sterile canvas in envelopes, spores.	Much > 34 yrs.	"	"
Wool, 80 C., mat'l shaken with sev. vol. st. salt sol..	30 minutes	Mackie	1934
Diseased cow blood dried on gauze, diffuse sunlight, spores.	40 years	McCulloch	1945
B. spp. (aerobic)			
Burlap strips, 200-280 F. 5-9 min., spores.	Yielded growth	Jungherr	1950
GLASS			
B. anthracis			
Glass rod, 37 C., Flamed with 95% alc., 10 sec.,		Mayser	1925
3 day old agar culture;	Viable 2 days		
6 day old bowl, cult..	33 days		
Porcelain dish, 12 cm. dia., 37 C., burned with alcohol 1 min, 3 day agar culture.	None recovered	"	"
Porcelain saucer, 37 C., burned with alc., 6 day culture.	None recovered	"	"
Shaving mug.	Two years	Vincent	1922
Glass slides, blood, slowly dried in moist air at R.T., stored in dry air at R.T..	Survived 60-90 das.	Minett	1950
Glass slide, dried, 56 C. 100 C., and 80 C..	Few days	Thurn	1914
PAPER			
B. anthracis			
Paper-slips, spores, sunlight.	8 hrs.	Weinzirl	1914
B. subtilus			
Paper-slips, sterile in petri plates, sunlight, spores.	8 hrs.	"	"
GENERAL			
B. anthracis			
Match head, 37 C., spores 95% alc. 3 da. cult.	Viable 2 das.	Mayser	1925

TABLE 4/ (CONT'D) THE SURVIVAL OF BACILLUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
GENERAL (CONT'D)			
Spores, R.T., dry-diffuse daylight.	50%, germinated in a few mos.; large no. of remaining 50% capable of germination for 10 years; All dead in 23 yrs.	Smith	1930
Shaving brushes, 80 C..	30 minutes	Mackie	1934
Brass wire, 5 cm., heated 37 C., flamed 95% alc., 3 day old agar culture.	Viable 9 days.	Mayser	1925
Shaving brushes	7.3% contained virulent anthrax bacilli	Symmers	1921
B. subtilus			
Catgut sutures, alcohol, toluol.	>17 days	Hite	1938
Metal, bullet lodged in flesh of soldier	>2 mos.	Pulvertaft	1929
Few viable one present on surfaces after cleaning and use of high pressure steam.		Peabody	1951
Hand telephones,	93.79 % organisms	Smeall	1937
Telephones with separate receiver and transmitter	92.59%	"	"

TABLE Su2 THE SURVIVAL OF BRUCELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
B. melitensis			
Dry dust of Malta	20-28 days	Horrocks	1906
Dry sterile dust	20 days	"	"
Dust	44 days	Kennedy	1905
Favorable conditions	6 weeks	Bang	1897
FABRICS			
B. abortus			
Burlap bag, dried in	5 days	Cameron	1932
Burlap sacking, dried in, unheated cellar	30 days	"	"
B. melitensis			
Cloth, dried on	17 days	Kennedy	1905
B. suis			
Sacking	4 weeks	Anon.	1933
B. spp.			
Wool, washed with water over 55 C., dried at 75-80 C. or heated 30 min. at 105-111 C..	--------------------	Cherkasskii	1938
GLASS			
B. abortus			
Glass, dried on	Survival several days	Cameron	1932

TABLE Su 3 THE SURVIVAL OF CLOSTRIDIUM SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRIC			
Cl. tetani			
Bandages, 200 C., heated in hot air oven	Recovered 0, 1 hr.	Murray	1949
Silk strips spores dried on, light, room temp.	Still viable, 3 1/2 mos.	Tizzoni	1891
Cl. welchii			
Cotton-wool swabs, 16-22 C., plain dry	5-20 col. at 24 hrs.	Rubbo	1951
plain moist	5-20 col. at 8 hrs.		
serum dry	20-50 col. at 24 hrs.		
serum moist	20-50 col. at 24 hrs.		
GENERAL			
Cl. tetani			
Stored in rubber-capped test tube in cupboards, rusty metal, room temp.,	18 years	Semple	1911
Tetanus spores	Remain viable at the site of inoculation for as long as 6 months	"	"
Talcum powder, 20 lbs. in autoclave	Survived	Sevitt	1949
Cl. sporogenes			
Catgut sutures, exposure to both alcohol and toluol	>17 days	Hite	1938

TABLE Ay 4 THE SURVIVAL OF COLIFORM SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
Escherichia coli			
Cotton-woolswab, 16-28 C.,			
plain, dry	No growth 8 hrs.	Rubbo	1951
plain, moist	50-200 col. at 24 hrs.	"	"
serum, dry	20-50 col. at 48 hrs.	"	"
serum, moist	50-200 col. at 48 hrs.	"	"
E. coli (with Hem. strep. Sarc. flava, and S. aureus)			
Blankets(47), sucked from, on E.N.T. ward.	14,400-7,344,000 per cu. ft. air.	Rountree	1946
Klebsiella pneumoniae			
Cotton-woolswab, 16-28 C.,			
plain, dry	No growth 8 hrs.	Rubbo	1951
plain, moist	50-200 col. at 24 hrs.	"	"
serum, dry	20-50 col at 48 hrs.	"	"
serum, moist	50-200 col. at 48 hrs.	"	"
GLASS			
E. coli			
Glass cover slips, air-dried, dark; vacuum, dried at -195 C..	Recovered 0 in 4 days	Shattock	1912
Ozone to sterilize the air in small room, temp. 15-16, humidity 60, cultures exposed and dried on pieces of glass for 9 hrs	No killing or inhibition of the bacteria was obtained	Galli	1914
Ground glass	Killed in 10 min.	Rebell	1950
Glass, sunlight	2 minutes	Weinzirl	1907
Glass, 37 C., Inoc. at 30 sec. 107,000	Recovered 0 at 15 min.	Bryan	1933
E. coli communis			
Dessicator, 16-18 C.,	60 days	Buckley	1906
Room Temperature	32.5 days	"	"
Moist chamber	98 days	"	"
PAPER			
E. coli			
Filter paper, dipped in culture, dried over sulfuric acid;	Recov. 0,1,10 and 25 col. in 17 hrs.	Walliczek	1894
dried in vacuum;	Recov. 28, 45, 78, and >1,000 col. in 45 min.	"	"
dried in air.	0 recovered in 18 hrs.	"	"
Filter paper, dried from peptone salt, 24 hr. cult	<28 hrs.	Chick	1900
Filter paper, stool dried on, dark	45 days	Dold & Ketterer	1944
Filter paper, watery stool	143 days	"	"
Paper, 28 C., dried	77 days	Kusama	1925
Paper, sunlight	Longer if in clumps 2-10 minutes	Weinzirl	1907

TABLE IV (CONT'D) THE SURVIVAL OF COLIFORM SPECIES ON SURFACES

Factor(s)	Survival	Reference	
PAPER(CONT'D)			
E. coli			
Filter paper, moist, Inoc. 251,000 at 30 sec.	149,000 in 15 minutes	Bryan	1933
E. coli communis			
Paper, dessicator, 16-18 C.	21 days	Buckley	1906
Paper, room temperature	7.5 days		
Moist chambers, paper	47.5 days		
Colon- aerogenes spp.			
Filter paper, 24 hr. agar cult., dry incubator at 37 C..	31 days	Hastings	1923
Paper infected with milk cultures	96 days	"	"
General			
Coliform group destroyed in drying process of paper production		Appling	1945
PLASTER			
E. coli communis			
Dessicator 16-18 C..	84.5 days	Buckley	1906
Room temperature	84 days		
Moist chamber	168 days		
UTENSILS			
Colon-aerogenes spp.			
Kitchen utensils, 91-100 C;	Effective in destroying colon-aerogenes group	Sellers	1944
Kitchen utensils, 41-60 C. colony count at 48 hrs.	41 colonies	"	"
Kitchen utensils, 61-80 C. colony count at 48 hrs.	19 colonies	"	"
WOOD			
E. coli			
Stumps, feces on, blizzard, inoc. 532,000/gm.;	0 recovered in 18 days	Tonney	1931
Spring, Inoc. 11,800/gm.;	0 recovered, 153 days	"	"
Warm season,	172 days		
Winter, pure cult., inoc.			
323,000/ gm.	0 recovered, 22 days	"	"
307,000/ gm	0 recovered, 9 days	"	"
Spring, pure culture	228 days	"	"
E. coli communis			
Dessicator, 16-18 C.			
Cotton wood	49 days	Buckley	1906
Lime wood	86 days		
Pine wood	22 days		
Room temperature		"	"
Cotton wood	64 days		
Lime wood	80 days		
Pine wood	14 days		
Moist chamber		"	"
Cotton wood	53 days		
Lime wood	168 days		
Pine wood	78 days		

TABLE 4 (CONT'D) THE SURVIVAL OF COLIFORM SPECIES ON SURFACES

Factor(s)	Survival	Reference	
WOOD(CONT'D)			
Aerobacter aerogenes			
Stumps, pure culture on,			
Winter, inoc. 708,000/gm.	0 recovered, 22 days	Tonney	1931
456,000/gm.	0 recovered, 9 days	"	"
Spring, pure culture	228 days	"	"
GENERAL			
E. coli			
Ultra-violet, low humidity	Bactericidal action is greatest.	Elford	1942
Ultra-violet, 45% R.H.	Almost 10 times as lethal as at 90% R.H.	"	"
Doorknob, brass	Recov. positive, 12 hrs Recov. 0, 24 hrs.	Frank	1943
Doorknob, white bronze	Recov. positive, 48 hrs.	"	"
Stuffing boxes of pumps, lub. grease	Abundance of growth	Frantsev	1935
Water filter, after water stopped	24-36 hrs.	Gage	1903
Continous filter	4-6 days	"	"
Action of metal salts, gold colloids, ferric chloride, silver nitrate, zinc chloride and others at varying dilutions	----------------------	Tanaka	1931

TABLE 245 THE SURVIVAL OF CORYNEBACTERIUM SPECIES ON SURFACES

Factor(s)	Survival	Reference
DUST		
C. diphtheriae		
Brick dust, 37 C., bacilli culture,	Kept full virulence during drying up period until death.	Germano 1897
air dried,	5184 col., 12 days	" "
dried with sulfuric acid	1728 col., 12 days	
C. diphtheriae gravis		
Present in dust	175 days	Laurell 1949
Dust, recov. with unimpaired toxicity	175 days	Ouchterlony 1949
Sawdust, mitis, gravis, and intermedius recov. with unimpaired toxicity	<1 day	" "
Occurrence in air and dust	----------------------	Trevelyan 1898
FABRICS		
C. diphtheriae		
Silk, dried on, R.T.	3-14 weeks	Abel 1893
Silk, dried on, dark.	Still alive 189 days	
Cloth, old dried out cult.	3-3 1/2 mos.	" "
Silk thread, -23 1/2 to 12 1/2 C., 2-4 da. old culture. Strain I;	Recovered no growth in 68 days	Abel 1895
Control, R.T., Strain I.	No growth 74 days	" "
Silk thread, strain II;	No growth 61 days	
control	No growth 86 days	
Silk thread, strain III;	No growth 61 days	
control	No growth 86 days	" "
Cloth, gravis strain, R.T. dried	Recovered mostly with unimpaired toxicity >145 days	Ouchterlony 1949
Linen--mitis; cotton--gravis and inter.; wool--gravis and inter..	Recovered mostly with unimpaired toxicity >98 days	" "
Dry towelling	Alive at end of 48 hrs.	Pease 1930
Cotton-wool swab, 16-22 C.		
gravis, plain dry	5-20 col. at 48 hrs.	Rubbo 1951
plain moist	5-20 col. at 8 hrs.	
serum dry	50-200 col. at 48 hrs.	" "
serum moist	50-200 col. at 48 hrs.	
Cotton swab, sterile, 37 C., 1 loop 24 hr. cult, with		
sterile horse serum;	Still alive at 24 hrs.	Van Reimsdijk 1924
without horse serum;	Most dead at 1 hr.	
Cotton plugs(40), R.T., in dark, placed on horse serum agar	7 plugs were negative 33 plugs positive in 24 hrs.	" " "
Linen	15 days	Lomry 1929
Cotton	15 days	
Wool	25 days	" "
Occurrence on clothes.	----------------------	Trevelyan 1898

TABLE 45 (CONT'D) THE SURVIVAL OF CORYNEBACTERIUM SPECIES ON SURFACES

Factor(s)	Survival	Reference
GLASS		
C. diphtheriae		
Dessicator 16-18 C.,	68 days	Buckley 1906
Room temperature,	24 days	
Moist chambers ,	51.5 days	
Petri dishes, empty, sterile R.T.	24-48 hrs.	Kirstein 1902
Glass, dried, virulent strain 1 billion/cc, 37 C.	37 days	Ross 1945
Glass, *intermedius* strain	Recovered mostly with unimpaired toxicity > 98 days	Ouchterlony 1949
Slides, sterile, 37 C.	3 days	Teague 1913
Glass, sunlight	2 min.	Weinzirl [redacted]
PAPER		
C. diphtheriae		
Dessicator 16-18 C.,	21 days	Buckley 1906
room temperature.,	6 days	" "
moist chambers	15 days	
Paper, *gravis* strain	Recovered mostly with unimpaired toxicity 159 days	Ouchterlony 1949
Paper, sunlight	Longer if in clumps, 2-10 minutes	Weinzirl 1907
PLASTER		
C. diphtheriae		
Dessicator 16-18 C.	73 days	Buckley 1906
Room temperature	37.5 days	
Moist chambers	75 days	
UTENSILS		
C. diphtheriae		
Knife blade, 60-80 F.	86 days	Ecklund 1932
WOOD		
C. diphtheriae		
Oak	8 days	Lomry 1929
Beech	8 days	
Resins	8 days	
Dessication, 16-18 C.		Buckley 1906
Cotton wood	88.5 days	
Lime wood	77 days	
Pine wood	20 days	
Room temperature		
Cotton wood	24 days	" "
Lime wood	41 days	
Pine wood	8.5 days	
Moist chamber		
Cotton wood	17.5 days	" "
Lime wood	75 days	
Pine wood	7 days	
GENERAL		
C. spp.		
Hand telephones	14.58 % diphtheroids	Smeall 1937
Telephone with separate receiver & transmitter	11.10 % diphtheroids	" "

TABLE Su 6

THE SURVIVAL OF DIPLOCOCCUS PNEUMONIAE ON SURFACES

Factor(s)	Survival	Reference	
DUST			
Dried cultures mixed with		Germano	1897
sterile dust;	2 days		
at 0 C.	8 days		
FABRICS			
Type I(smooth			
Dried rabbit blood on		Stillman	1940
gauze, dark	2 mos.		
40 F., ice box, dark	9 mos.		
Typ I(rough		"	"
Gauze, 80 F.,daylight	Viable 10 mos.		
Gauze, 80 F., dark	Viable 15 mos.		
Gauze, 40 F., dark	9 mos.		
Type II(smooth			
Gauze, rabbit blood dried,			
80 F., daylight and dark	2 mos.	"	"
40 F., in icebox, dark	12 mos.		
Type II(rough		"	"
Gauze, 80 F, daylight	9 mos.		
dark	13 mos.		
Gauze, icebox, 40 F, dark	8 mos.		
Dry towelling, including turkish towel	Alive at end of 24 hrs.	Pease	1930
Type III(smooth			
Gauze, daylight, 80 F.	5 mos.	Stillman	1940
Gauze, dark, 80 F.	11 mos.		
Gauze, 40 F. icebox, dark	12 mos.		
Type III(rough		"	"
Gauze, 80 F., daylight	7 mos.		
Gauze, 80 F., dark	9 mos.		
Gauze, icebox, 40 F, dark	9 mos.		
Type III			
Cotton wool swab, plain			
dry	5-20 col. at 8 hrs.	Rubbo	1951
plain, moist	5-20 col. at 8 hrs.		
serum, dry	5-20 col. at 48 hrs.		
serum, moist	20-50 col. at 24 hrs.		
Pneumococci life slightly longer on cloth than on non-absorbing surfaces		Wood	1905
GLASS			
Type I(smooth			
Glass, dried rabbit blood,			
80 F,daylight	1 mo.	Stillman	1940
40 F, icebox, dark	12 mos.		
Type I(rough		"	"
Glass, 80 F.,daylight	Viable 10 mos.		
dark	" 11 mos.		
Glass, 40 F, dark	" 15 mos.		
Type II(smooth			
Glass, dried rabbit blood,			
80 F., daylight and dark	2 mos.		
40 F., dark	12 mos.		

TABLE 46 (CONT'D) THE SURVIVAL OF DIPLOCOCCUS PNEUMONIAE ON SURFACES

Factor(s)	Survival	Reference
GLASS		
Type II(rough		
Glass, 80 F., daylight	3 mos.	Stillman 1940
dark	9 mos.	
40 F., dark	9 mos.	
Type III(smooth		
Glass, dried rabbit blood,		
80 F., daylight	5 mos.	Stillman 1940
80 F., dark	7 mos.	
40 F., dark	13 mos.	
Type III(rough		
80 F., daylight	0 mos.	" "
80 F., dark	1 mo.	
40 F., dark	7 mos.	
Diplococcus--at this age no known difference between meningococci and pneumococci. Dried rabbit blood on watch glass	>45 days	Foá 1888

TABLE 547

THE SURVIVAL OF MICROCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
<u>M. pyogenes</u>			
Burlap strips	14 days--test negative	Jungherr	1950
Garments, dried on, liquid air	Several mos., no change in resistance	Paul	1907
<u>M. pyogenes var. aureus</u>			
Cotton-wool swab, plain dry;	20-50 cols. at 48 hrs.	Rubbo	1951
plain, moist;	20-50 cols. at 24 hrs.		
serum, dry;	50-200 cols. at 48 hrs.		
serum, moist.	50-200 cols. at 48 hrs.		
Handkerchief, nasal secretions, dried	>1 mo.	Duguid	1948
Handkerchief, sterile, dark, R.T., single nose blow	1 mo.	"	"
Handkerchiefs, disinfected with various % of various disinfectants, inoc. with org., remained overnight at 70 F., cultured	3.0% to 39 % survivors	Dumbell	1949
Cotton squares, treated as above, wider range of conc. of disinfectants	0.2% to 100% survivors	"	"
Blankets(47), ENT ward, hemolytic strep., <u>Sarc. flava</u>, <u>E.coli</u>, <u>Staph aur.</u>	14,400-7,344,000/cu.ft. of air.	Rountree	1946
<u>M. pyogenes var. albus</u>			
Woolen serge, aqueous susp. 0.44 ppm. zone, R.H. 70%, 20 C , exposed 90 min.	54% killed	Elford	1942
Woolen serge, serum broth, 0.5ppm. zone, R.H. 70%, 21 C., exposed 30 min.	Nil	"	"
GLASS			
<u>M. pyogenes var. aureus</u>			
Glass, dessicator, 16-18 C.	90 days	Buckley	1906
Glass, room air	53 days		
Glass, moist chamber	74 days		
Petri dishes, empty, steril R.T..	8-10 days	Kirstein	1902
Glass cover slips, dried at -195 C., kept in vacuum	4-15 weeks	Shattock	1912
Glass cover slips, air dried	16-22 days, dead on 40	"	"
Glass slides, dried	Few days	Thurn	1914
Glass, 37 C., innoc 225,000.	Recovered 97,000, 15 min	Bryan	1933

TABLE Su 2 THE SURVIVAL OF MICROCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
GLASS (CONT'D)			
M. pyogenes var. aureus			
Sterile dishes, put into machine with soiled dishs 0.3% calgonite		Ward	1937
% sterile after wash	10 %		
% sterile after 1st rinse	15 %	"	"
% sterile after 2nd rinse	32 %		
Average no. of bacteria/dish remaining contaminated after wash	14		
after 1st rinse	4	"	"
after 2nd rinse	6		
Max. no. of bact./dish remaining contaminated wash	14	"	"
1st rinse	4		
2nd rinse	6		
Soiled dishes, % sterile after wash in machine	10%	"	"
after 1st rinse	16-30 %		
after 2nd rinse	12-28 %		
Glass, 20 and 9-12 C., inoc. 300,000/0.1cc in a 24 hr. cult., dark	Recovered almost 100% in 48 hrs.	Lehmann	1931
M. pyogenes var. albus			
Glass, aqueous susp'n, 0.44 ppm ozone, R.H. 70%, 20 C., exposed 90 min.	> 99% killed	Elford	1942
Glass, serum broth R.H. 70%, 0.5ppm ozone, 21 C., exposed 30 min.	Nil	"	"
Glass, cult. exposed to ozone, 15-16 C, R.H. 60%. Dried for 5,6,9 hrs.	No killing or inhibition of the bacteria was obtained	Galli-Valerio	1914
M. pyogenes (Gen'l)			
Slides, sterile, 37 C., innoc. innumberable cols.	Recovered 41 col., in 7 days	Teague	1913
Glass, direct sunlight	60-90-minutes	Weinzirl	1907
Glass, direct sunlight	10 min.	Weinzirl	1907
PAPER			
M. pyogenes var. aureus			
Paper, dessicator, 16-18C	66 days	Buckley	1906
Paper, room air	70 days		
Paper, moist chamber	51 days		
Filter paper, test org.	Survived longer on skin than on filter paper	Hellot	1948
Paper, surface, agar plates, inoc. 1800;	Recovered 400, 3 min.	Norton	1932
inoc. 900.	Recovered 46 , 3 min.	"	"
Filter paper, moist, 37 C. inoc. 173,000	Recovered 170,000 15 min.	Bryan	1933

TABLE ~~Ia~~ 2 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
PAPER(CONT'D)			
M. pyogenes var. albus			
Filter paper, aqueous susp'n, 0.44 ppm ozone, R.H. 70%, 20 C., exposed 90 min.	80% killed	Elford	1943
Filter paper, serum broth 0.5 ppm.ozone, R.H. 70%, 21 C., exposed 30 min	Nil	"	"
M. pyogenes			
Paper, sunlight	71 hrs.	Weinzirl	1907
PLASTER			
M. pyogenes var. aureus			
Plaster, dessicator, 16-18 C.;	100 days	Buckley	1906
room air,	100 days		
moist chamber.	38 days		
RUBBER			
M. pyogenes var. aureus			
Rubber sheet, susp'n containing 2568 org., exposed 7 minutes.	807 washed off	Burtenshaw	1938
Rubber sheet, susp'n of 2568 org., exposed 92 minutes.	[illegible] washed off		
Rubber sheet, susp'n of 3459.2 org., exposed 6 minutes.	923.6 washed off	"	"
Rubber sheet, susp'n of 3459.2 org., exposed 92 min.	192.4 washed off	"	"
UTENSILS			
M. pyogenes var. aureus			
Glazed porcelain dishes, cold water without serum	34 colonies--1 hr. 198 " " --3 hrs. 29,000 colonies--5 hrs.	Blumenberg	1927
With serum	514 colonies--1 hr. 3,500 col.--3 hrs. 100,000 col.--5 hrs.		
Unglazed chinaware, 37 C, rinsed in warm flowing water, with serum	1300 cols. -1 hr. 25,000 cols.--3 hrs. >1 Million cols-- 5 hrs.	"	"
without serum	51 cols.--1 hr. 640 cols.--3 hr. >300,000 cols-- 5 hrs.	"	"
Glazed china, without serum	6 cols.--1 hr. 44 cols.--3 hr. 5000 cols.-- 5 hrs.		

TABLE Su 7 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference
UTENSILS (CONT'D)		
<u>M. pyogenes var. aureus</u>		
Glazed china, rinsed with warm flowing water, 37 C. with serum	78 cols.-- 1 hr. 820 cols.-- 3 hrs. 38,000 cols.-- 5 hrs.	Blumenberg 1937
Glazed china, rinsed in warm flowing 2% soda sol'n, without serum;	2 cols.--1 hr. 12 cols.--3 hrs. 311 cols.--5 hrs.	" "
with serum	13 cols.--1 hr. 90 cols.--3 hrs. 1640 cols.--5 hrs.	" "
Unglazed china, rinsed in warm flowing 2 % soda sol't, 37 C. with serum	1090 cols.--1 hr. 3200 cols.--3 hrs. 7,300,000 cols.--5 hrs.	" "
without serum	10 cols.--1 hr. 176 cols.-- 3 hrs. 16,600 cols.--5 hrs.	" "
Knife blade, 60-80 F.	12 wks. & 2 das. (86 da)	Ecklund 1932
Food utensils, large collection, washed	3-12 % recovery	Hutchinson 1947
WOOD		
<u>M. pyogenes var. aureus</u>		
Dessicator, 16-18 C.		
lime wood	126 days	Buckley 1906
pine wood	64 days	
cotton wood	130 days	
Room air		
lime wood	126 days	" "
pine wood	39 days	
cotton wood	122 days	
Moist chamber		
lime wood	100 days	" "
pine wood	35 days	
cotton wood	38 days	
GENERAL		
<u>M. pyogenes var. aureus</u>		
Tinfoil, susp'n containing 2568 orgs. exposed 11 min;	973.4 washed off	Burtenshaw 1938
Same susp'n at 100 min.	194.7 washed off	
Tinfoil, susp'n containing 3459.2 orgs., exposed 8 min.	1011.2 washed off	" "
Same susp'n at 96 min.	316 washed off	
Smooth surfaces, ultraviolet, 2,000-2,950 A units	Effect reduced counts	Cathcart 1942
Hand telephone	4.17 %	Smeall 1937
Telephone with separate receiver and transmitter	3.7%	" "

TABLE Su 7 (CONT'D) THE SURVIVAL OF MICROCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
GENERAL (CONT'D)			
M. pyogenes, var. aureus			
Action of metal salts, gold colloids, silver nitrate, zinc chloride and others in varying dilutions.	....	Tanaka	1931
M. pyogenes var. albus			
Hand telephones	35.42 %	Smeall	1937
Telephones with separate receiver and transmitter.	11.10 %	"	"
M. pyogenes			
Doorknob, brass	Recov. positive 24 hrs. Recov. negative 38 hrs.	Frank	1943
Door knob, white, bronze	Recov. positive 72 hrs.	"	"
M. spp. (chromogenic cocci)			
Hand telephones	62.50 %	Smeall	1937
Telephones with separate receiver & transmitter	11.10 %		

TABLE Su 8 THE SURVIVAL OF MICROORGANISMS ON SURFACES

Factor(s)	Survival	Reference	
DUST			
<u>Proteus morgani</u>			
Dust	2-12 d.	Hoare	1943
FABRICS			
<u>Proteus vulgaris</u>			
Cotton-wool swab, 16-22C,			
plain, dry	No growth at 8 hr.	Rubbo	1951
moist	50-200 col. at 24 hr.	"	"
Cotton-wool swab, 16-22C,	20-50 col. at 48 hr.	"	"
serum, dry			
moist	50-200 col. at 48 hr.	"	"
<u>Hemophilus pertussis</u>			
Cotton-wool swab, 16-22C,			
plain, dry	No growth at 8 hr.	"	"
moist	" " " " "	"	"
Cotton-wool swab, 16-22C,			
serum, dry	20-50 col. at 24 hr.	"	"
moist	20-50 " " " "	"	"
<u>Proteus morgani</u>			
Blanket	>81 d.	Hoare	1943
<u>Rickettsia</u>			
<u>Coxiella burnetii</u>			
Soiled laundry from Q fever lab.	Infection evident on laundry workers handling prior to laundering	Oliphant	1949
<u>Treponema pallidum</u>			
Cloth, 21.5-25C, diffuse light	11½ hr.	Zinsser	1914
<u>Vibrio comma</u>			
Dried on silk threads in air, temp of desiccator	30 d.	Berckholz	1889
Thread	7 mo.	Ficker	1898
Ster. moist linen strips, R.T.	Still viable 5 wk.	Gamaleia	1893
Dry linen strips	Recov. 0, 17 hr.	"	"
Dried on silk threads in desiccator	3-4 d.	Kitasato	1889
Cotton-wool swab, 16-22C,			
plain, dry	No growth at 8 hr.	Rubbo	1951
moist	" " " " "	"	"
Cotton-wool swab, 16-22C,			
serum, dry	" " " " "	"	"
moist	5-20 col. at 24 hr.	"	"
Clothing especially linen	Several days even weeks	T. & W.	1946
GLASS			
<u>Pseudomonas aeruginosa</u>			
Glass, 24 hr. peptone, 1% ~~water~~ culture, vacuum dried	7 mo. & 7 d.	Shottoch	1912
Glass, sunlight	2 min.	Weinzirl	1907

TABLE Su 8 (CONT'D) THE SURVIVAL OF MICROORGANISMS ON SURFACES

Factor(s)	Survival	Reference	
GLASS (cont'd)			
Sarcina aurantiaca			
Glass (direct and under glass) sunlight	25-60 min.	Weinzirl	1907
Treponema pallidum			
Glass slides allowed to dry	4½ hr.	Zinsser	1914
Vibrio comma			
Vibrio dried on cover slip	3 hr.	Kitasato	1889
Ster. slides, 37C,	Inoc. innumerable, Recov. 0, 2 min.	Teague	1913
Glass slides dried	Few days	Thurn	1914
" " , 56, 100, & 80C	30 min.	"	"
Glass sunlight	2 min.	Weinzirl	1907
PAPER			
Bacterium linens			
Ster. filter paper, dried, R.T.	Inoc. soaked in 48 hr. cult. in peptone, still gave active org. when placed in peptone 90 d.	Albert	1944
Proteus morgani			
Filter paper	11-20 d.	Hoare	1943
Vibrio comma			
Banknotes touched by fingers infected with cholera stool	4 hr.	Jettmar	1927
WOOD			
Trichomonas vaginalis			
Enamel surface of a small wooden block	< 7 hr.	Kessel	1950
GENERAL			
Alcaligenes faecalis			
Hand telephones	4.17% of org. present	Smeall	1937
Rickettsia typhi			
In a vacuum with $CaCl_3$ for 48 hr.	100 d. still viable	Blanc	1940
Paper, R.T.	Still viable at 21 d.	"	"
Trichomonas vaginalis			
Natural conditions	Long enought to permit transfer to another	Kessel	1950
Vaginal discharge	Recov. 2-4%, 6 hr.	"	"
Vibrio comma			
Inside earthen pot	2 d.	Arguelles	1927
Outside " "	4-8 d.	"	"

TABLE Su 9 THE SURVIVAL OF MICROORGANISMS ON SURFACES (GENERAL)

Factor(s)	Survival	Reference	
DUST			
Air during dust storm	High ct. of mold, bacteria, & dust particles	Proctor	1935
FABRICS			
Oiled blankets	90-95% fewer than contrl	Dingle	1946
Egypt cotton parachute material, dry over nite 70F, dust free room, shaking for 30 sec.	Recov. 14,720	Dumbell	1948
Mechanical shaking 30sec.	Recov. 60,300	"	"
Violent shaking	" 136,000	"	"
Turkish towel	24 hr.	Pease	1930
10 blankets untreated and in use for 4 mo.	Near 6,200,000/gm. of blanket	Rountree	1947
Blankets	6 mo.	Shechmeister	1947
Org. were killed more rapidly on glass surfaces than woolen serge, filter paper, or blood agar		Elford	1945
GLASS			
Drying in tubes	.5 hr.	Buckley	1907
" " desiccator	" "	"	"
" " R.T.	1.75 hr.	"	"
" " Moist chamber	8 d.	"	"
Cover slips, dried	1 mo.	Sternberg	1950
Glass, 12 specimens	>1 millon	MacNabb	1938
METAL			
Surfaces of Fe, Zn, Cu, brass, limewash, lead paint & too were bactericidal		Minett	1950
Polio virus-partial inactivation		McKhann	1948
PAPER			
Spore bearing bacteria survive drying process of paper.		Appling	1945
Drying in tubes	1.5 hr.	Buckley	1907
" " desiccator, 16-18 degrees C	1.75 hr.	"	"
Drying in R.T.	5 hr.	"	"
Moist chamber	5 d.	"	"
WOOD			
Drying in tubes:			
cotton wood	.25 hr.	Buckley	1907
lime wood	1.5 hr.	"	"
pine wood	1.5 hr.	"	"
Drying in desiccator:			
cotton wood	7.5 hr.	"	"
lime wood	" "	"	"
pine wood	1.5 hr.	"	"
Drying R.T.:			
cotton wood	9 hr.	"	"
lime wood	8 hr.	"	"
pine wood	7.5 hr.	"	"
Drying moist chamber:			
cotton wood	14.5 d.	"	"
lime wood	19 d.	"	"
pine wood	1 d.	"	"

TABLE 4-9 (CONT'D) THE SURVIVAL OF MICROORGANISMS ON SURFACES (GENERAL)

Factor(s)	Survival	Reference	
GENERAL			
Bact. found in bricks 1,005	400 yr. old.	Lipman	1934
Ster. of plane polished surfaces			
Sterilization of plane polished surfaces by air at 50 miles/min.	Slightly longer time for sterilization	Breinl	1935
at 300-600 mi./min.	Effect pronounced	"	"
Sterilization of polished surfaces by still air	50-60 min.	"	"
at 100-120C, 600 mi./min.	10-15 min. for killing	"	"
Ozone in excess of 1p.p.m., R.H. 60-80%	Good sterilization	Elford	1942
Survive well in temp. colder than CO_2 frozen		Lujet	1938
Survival temp. ranging from that of liquid O_2, -183C to that of liquid helium, -269C.		"	"
Drying on tubes	0.5 hr.	Buckley	1907
" in desiccator	3 hr.	"	"
Drying in moist chamber	7 d.	"	"
Drinking utensils, 51 specimens examined: 12 greater than 1 millon, 5 greater than 1 thousand to 1 millon, 17 greater than 1 to 1 thousand.		MacNabb	1938

TABLE Su 10

THE SURVIVAL OF MYCOBACTERIUM TUBERCULOSIS ON SURFACES

Factor(s)	Survival	Reference	
DUST			
Dust, infected, diffuse daylight	5 days	Soparkar	1917
Dust, infected, direct sunlight	2 hrs.	"	"
Dust, infected	8 days	Kirstein	1905
Street dust, infected	3-8 days	"	"
Sterile dust, mixed with T.B., direct sunlight	5 hrs	Sweeny	1919
Film of dust, south room	5 days	"	"
Film of dust, north room	7 days	"	"
FABRICS			
Garments worn by tubercular patients, dust and scrapings	Unable to infect g.p.	Jacobs	1944
Linen or woolen cloth, with sputum, sunlight	24-30 hrs	Migneco	1895
Handkerchief, sputum, dried in sun	18 hrs	"	"
Carpet, sputum	Infective 39 days	Twitchell	1906
Handkerchief or blanket	Lesions resulted after 70 but not after 110 da	"	"
exposed to direct sunlight	Infective after 1 hr. but not after 7 hrs.	"	"
On threads of clothing	5-10 days	Kirstein	1905
GLASS			
Glass, sputum dried in thin smears	4 mos.	Sormani	1886
PAPER			
Books, handled by tubercular patients	Unable to demonstrate viable tubercle bacilli	Jacobs	1944
Sheets of paper coughed on, stored in bell jar,	>50 % infective, 2 das. infection for g.p., no infection 31 days	"	"
Paper, sunlight, known type	2-10 mins.	Weinzirl	1907
Paper, under glass, No.101 tubercle culture	1 1/2 hr.		
Paper, and moisture under glass, No. 101 culture	1/2 hr.	"	"
Paper, No. 101 culture	15-20 min.		
Paper and moisture under glass, No. 110 culture	1/2 hr.	"	"
Paper under glass, No. 110	<10 min	"	"
Paper, moisture, sunlight, No. 101	25-30 min	"	"
Paper, sunlight, No. 101	25 min.		
Paper, sunlight, No. 101, under colorless glass	5 min.	"	"
under red glass	10-20 min.		
under green glass	30 min.	"	"
under blue glass	5-10 min.		

TABLE Surv (CONT'D) THE SURVIVAL OF MYCOBACTERIUM TUBERCULOSIS ON SURFACES

Factor(s)	Survival	Reference	
PAPER(CONT'D)			
Paper, infected, dried 24 hrs., exposed to little air	> 35 days	Ransom	
Books, sputum.	2 wks. to 3 1/2 mos.	Smith	1942
GENERAL			
Thin smears of human, bovine and avian types, sunlight	Killed in 1-4 min.	Briscoe	1912
Dessication in a dark, well-ventilated place--human and bovine.	Killed human within 4 days; killed bovine " within 8 days.	"	"
Exposed to direct sunlight in India.	Alive---6 das. Dead----8 das.	Soparkar	1917
Dessiccated in darkness.	Live virulent bacilli for 309 days.	"	"
Decomposing sputum.	20-26 days		
Exposed to electric light, bovine t.b.,	74 days alive, dead in 100 days.	"	"
Bovine t.b. from deer lung, direct sunlight; diffuse light.	10-12 hrs. 30 days	"	"
Hypochlorite disinfection and quarternary ammonium compounds had weak tuberculocidal power.		Klarman	1951
Braille books	3 mos.	Chapin	1926

TABLE ~~4~~ 11 THE SURVIVAL OF NEISSERIA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
N. gonorrhoeae			
Cotton plug in closed tube under water	0 recovered, 24 hrs.	Lorentz	1924
Cotton plug in open tube	0 recovered, 30 min.		
Cotton plug in incubator, 40 C.	0 recovered, 10 min.	"	"
Cotton plug in sun(summer)	0 recovered, 5 min.	"	"
Cotton plug, R.T.	0 recovered, 5 min.		
Cotton-wool swabs, also *N. meningitidis*, 16-22C.			
plain dry;	No growth at 8 hrs.	Rubbo	1951
Plain moist;	No growth at 8 hrs.		
serum dry;	No growth at 8 hrs.		
serum moist.	No growth at 8 hrs.		
N. intracellularis			
Cotton fabrics	7 days, survival shortened at 37 C, & prolonged at 6-10 C.	Miller	1944
Cotton-wool swabs, also *N. gonorrhoeae*, 16-22 C.			
plain, dry	No growth at 8 hrs.	Rubbo	1951
plain, moist	No growth at 8 hrs.		
serum, dry	No growth at 8 hrs.		
serum, moist	No growth at 8 hrs.		
Cotton fabrics exposed to direct sunlight in dried films	Few hrs.	Miller	1944
Cotton gauze, exposed to diffuse daylight, passing thru window pane, & pyrex petri dish	30 hrs.	"	"
Fabric	1 hr. still alive, 2 hrs. dead	Weiss	1921
GLASS			
N. meningitidis			
Glass beads, dark, dried, R.T.	10 days, visible light is germicidal.	Miller	1944
Surface glass, direct sun light, in dried films	Few hours	Miller	1944
Glass beads, diffuse daylight, passing thru window pane & pyrex petri dish	30 hrs.	"	"
Glass, drying on	72 hrs.	Elser	1909
Garnets and glass, dried,			
in dark	24 hrs.	Flügge	1905
diffuse daylight	10 hrs.		
Glass, dried, R.T.	24 hrs.	Kutscher	1906
Watch glass, dried rabbit blood	>45 days	Foá	1888

TABLE Su11 (CONT'D) THE SURVIVAL OF NEISSERIA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
GLASS (CONT'D)			
N. gonorrhoeae			
Glass covered in sun	2 strains stopped growing after 3 hrs.; 5 hrs. no growth	Lorentz	[illegible]
WOOD			
N. meningitidis			
Wood exposed to direct sunlight in dried films	Few hrs.	Miller	[illegible]
Wood, room temperature	8 days	"	"
GENERAL			
N. meningitidis			
Human secretions, drying in,	Several days	Jungeblut	1935
Metal	1 hr still alive, 2 hrs. dead	Weiss	[illegible]
15 strains, R.T., 25-26 C., dark,	9 strains survived 2 wks 6 for 4 wks. 0 survived for 5 wks.	Elser	[illegible]
diffuse daylight,	1 wk.	"	"
direct sun	8-9 hrs.		
ice box, 6-8 C.	None survived a week		
Meningococci might remain alive for years if dried rapidly under freezing temperatures and kept frozen		Elser	1909

TABLE Sy 12 THE SURVIVAL OF PASTEURELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
<u>P. pestis</u>			
Silk cloth, protected from light	0 recovered, 1-21 days	Gladin	1898
Handkerchief	0 recovered, 14 days		
Coarse linen	0 recovered, 12-76 days	"	"
On silk cloth in sun	0 recovered, 6½ hrs.		
On linen in sun	0 recovered, 18½ hrs.	"	"
GLASS			
<u>P. pestis</u>			
Cover glass, dried bubonic pus, 28-30C, inoc into bouillon	No growth, 4 days	Abel	1897
Cover glass, pure cult., dried, 29-31C	No growth, 4½ days	"	"
Desiccator, dess. temp.	No growth, 3 hrs.		
Dried in lighted room, 16-20C	No growth, 3 hrs.	"	"
Cover glass, pus & cult., room temperature	Still viable 6-9 days		
Cover glass, finely divided, dried in sun, 30C	No growth, 1 hr.		
Cover glass, dried	No growth, 1 hr.	"	"
Desiccator, 16-18C	3.5 hrs.	Buckley	1906
Glass, room temperature	2.3 days	"	"
Glass, moist chamber	13.5 days		
Cover glass, 14-24C protected from light	None recovered, 1-9 d.	Gladin	1898
Cover glass, dried by sun	None recovered, 1¼ hrs.	"	"
Test tube, sun, 40-44C	Still alive, 5½ hrs.	"	"
Cover slip, R.T., bubo juice, dried	< 4 days	Kitasato	1894
exposed to sun	3-4 hrs.		
Slide, dried, Giemsa stain, inoc. 1:1,000	Viable 2 hrs.	Tinker	1930
Slide, reagents used for hemoglobin determination	Kill organism in 45 min.	"	"
<u>P. spp.</u>			
Glass tube, blood allowed to putrify	100 days	Ostertag	1908
PAPER			
<u>P. pestis</u>			
Desiccator 16-18C	5 days	Buckley	1906
Room temperature	3.6 days		
Moist chamber	8.3 days	"	"
Filter paper, dried, 14-24C, protected from light	None recovered, 1-20 d	Gladin	1898
<u>P. tularense</u>			
Filter paper, feces on, 20C, dried unexposed to direct light	20 days	Francis	1922

TABLE 4/12 (CONT'D) THE SURVIVAL OF PASTEURELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
PLASTER			
P. pestis			
Dessicator, 16-18 C.	9.5 days	Buckley	1906
Room temperature	5 days		
Moist chamber	11 days		
WOOD			
P. pestis			
Dessicator, 16-18 C.		Buckley	1906
Cotton wood	22 days		
Lime wood	6.5 days		
Pine wood	3.5 days		
Room temperature			
Cotton wood	11 days	"	"
Lime wood	2 days		
Pine wood	-------		
Moist chamber			
Cotton wood	36.3 days	"	"
Lime wood	2.6 days		
Pine wood	1 hour		
GENERAL			
P. pestis			
Frozen daily, -20 C..	40 days	Gladin	1898
Dried, 37 C..	Most were dead, 3 das.		
Protected from sun, 37 C..	2-3 mos.		
Protected from sun, R.T..	260 days	"	"

TABLE 13 THE SURVIVAL OF SALMONELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
S. typhosa			
Dried soil(dust), stock culture, avg. temp. 52 F., Max. temp. 57 F., Min. temp. 49 F.	>22 days	Firth	1902
Dried soil, stool cult., avg. temp. 51 F., max. temp. 55 F., min. temp. 48 F..	>30 days		
Dust, stool cult., avg. temp. 53 F., max. 55 F., min. 4 F..	>20 days	"	"
Street dust.	30 days	Osler	1901
Sweeping, bedroom, sterile R.T., dried after 16 hrs. & wetted with inoc. of bacterial water susp'n, 12 mm. layer.	36 days	Uffelmann	1894
Street sweepings, sterile	32 days		
Sweepings, kitchen refuse	30 days	Kister	1928
Ashes, contaminated	130 days		
S. typhimurium			
Dust	3 weeks	Browne	1949
S. paratyphi			
Sweepings, kitchen refuse.	50 days	Kister	1928
Ashes, contaminated.	130 days	"	"
FABRICS			
S. typhosa			
Soiled washing, R.T., dark	4 days	Dold	1944
Linen, dried on	98 days		
White drill cloth, temp. 105 F., exposed to sun, inoc. 240,000	2 hrs.	Hewlett	1909
White drill cloth, 92 F., dark	76 days	"	"
White drill cloth, soaked in urine with org., in dark, inoc. 240,000	10 days	"	"
Turkish towels	Alive at end of 48 hrs.	Pease	1930
Cotton-wool swab, 16-22 C.		Rubbo	1951
plain, dry	No growth at 8 hrs.		
plain, moist	5-20 col. at 24 hrs.		
serum, dry	5-20 col. at 24 hrs.	"	"
serum, moist	20-50 col. at 48 hrs.		
Dried on linen	98 days	Dold	1943
Linen	150 days	Lomry	1929
Cotton	150 days		
Wool	100 days	"	"
Linen	60-70 days	Osler	1901
Linen, suspn.	Viable 97 days	Pfuhl	1902
Linen, sterile, 1:3 dil't	90 days	Uffelmann	1894
Buckskin, sterile	100 days		

TABLE ~~14~~ 13 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
S. enteritidis			
Dried on linen	39 days	Dold	1944
S. paratyphi B			
Dried on linen	191 days	"	"
Turkish towels	Alive at end of 48 hrs.	Pease	1930
S. paratyphi			
Dried on linen	191 days	Dold	1943
Linen	150 days	Lomry	1929
Cotton	150 days		
Wool	70 days	"	"
S. pullorum			
Burlap strips, soaked in cult., exposed to U.-V.,	No inactivation	Jungherr	1950
200-215F. for 5 min.	Was not isolated after 5 min exposure		
95-180 F. for 4 min.	Readily recovered		
205-270 F. for 5-7 min.	Not recovered		
S. sp. (*Type Oranienburg*)			
Cotton wick of water devise	15 days	Olson	1950
GLASS			
S. typhosa			
Dessicator, 16-18 C.	44.5 days	Buckley	1906
Room temperature	12 days		
Moist chamber	38.5 days		
Petri dishes, empty, R.T., sterile	24 hrs.	Kirstein	1902
Glass rod, sterile, 37 C. flamed with 95% alc. for 5 sec., 24 hr. agar cult	Viable 2 days	Mayser	1925
Porcelain saucer, 37 C., 1 eating, spoon of alc. 1 min. 24 hr. cult.	None recovered, 3 days	"	"
Glass cover slips, vaccum dried at -195 C; air dried , dark	None recovered, 4 days	Shattock	1912
Sterile slides, 37 C., inoc. innumerable cols.	None recovered,60 hrs.	Teague	1913
Dishes washed with 0.3% Calgonite, % sterile,			
sterile dishes	70-90% approx.	Ward	1939
soiled dishes	4-10%		
Glass, sunlight	5 min.	Weinzirl	1907
Self sterilizing ability of skin against *S. typhosa* similiar phenomenon on glass rods.		Dold	1919
S. sp. (*Type Oranienburg*)			
Glass, few drops broth culture.	34 days	Olson	1950

TABLE Su 13 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
PAPER			
S. typhosa			
Dessicator, 16-18 C.	13 days	Buckley	1906
Room temperature	5.3 days		
Moist chamber	10.5 days		
Paper slips, in vapor of 35 gms. plus/1000 ft^3	Recovered none, 1 hr.	Hewlett	1939
Filter paper, stool dried on, R.T.	>55 days	Dold & Ketterer	1944
Filter paper, thin watery stool	>137 days		
Filter paper, dried	1-2 wks	Joe	1950
Paper, surface, inoc. 56	Recovered none, 3 min.	Norton	1932
Paper, surface, inoc.1,500	Recovered none, 3 min.	"	"
Paper, sunlight	2-10 min., longer if in clusters	Weinzirl	1907
S. paratyphi			
Dried on filter paper, dark, R.T.	Pure cult. of org.>8 mo.	Dold & Ketterer	1944
Filter paper, dried on	421 days	Dold	1947
Filter paper, stool, dried,	1-2 wks.	Joe	1950
Paper, sunlight	2-10 mins., longer if in clumps	Weinzirl	1907
PLASTER			
S. typhosa			
Dessicator, 16-18 C.	83 days	Buckley	1906
Room temperature	91 days		
Moist chamber	101 days		
WOOD			
S. typhosa			
Dessicator, 16-18 C.			
cotton wood	50 days	Buckley	1906
lime wood	89 days		
pine wood	38.5 days		
Room temperature			
cotton wood	64 days	"	"
lime wood	91 days		
pine wood	9 days		
Moist chamber			
cotton wood	59 days	"	"
lime wood	119 days		
pine wood	12 days		
Wooden bowl, 20cm dia., 37 C., 1 eating spoon of Alc., 1 min. flaming, bouillon culture	Viable 2 days	Mayser	1925
Oak	80 days	Lomry	1929
Beech	80 days		
Resins	80 days		
Wood	32 days	Osler	1901
On bench	Recov. 17.0%, 23 days	Stamp	1947

TABLE Su 13 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
WOOD(CONT'D)			
S. typhosa			
Pine or fir-wood plank, incubator temp., water sus'p in a thin layer, 1:3 firs to water	32 days, decreasing by degrees	Uffelmann	1894
S. paratyphi			
Oak	80 days	Lomry	1929
Beech	80 days		
Resins	80 days	"	"
On bench	Recov. 17.0%, 23 days	Stamp	1947
GENERAL			
S. typhosa			
Bread, on surface after baking	30 hrs.	Alves	1935
Rye bread, on crust of, in well-ventilated room, at R.T.	4 1/2-6 mos.(longer survival at lower temp. -5 to -25 C.	Bachman	1943
Water filter after water stopped	2-3 hrs.	Gage	1903
In continuous water filter	2 days	"	"
Iron	20 days	Lomry	1929
Copper	20 days		
Tin	30 days	"	"
S. paratyphi			
On crust of rye bread, in well-ventilated room at R.T., emulsion with S. typhosa	4 1/2 - 6 mos., longer survival at lower temp. -5 to -25 C.	Bachman	1943
Iron	30 days	Lomry	1929
Copper	20 days		
Tin	40 days	"	"
S. enteriditis			
Smooth surface, ultra-violet rays, 2,000-2,950 Å units	Effect reduced counts	Cathcart	1942

TABLE Su 14 THE SURVIVAL OF SERRATIA MARCESCENS ON SURFACES

Factor(s)	Survival	Reference	
FABRICS			
Serge, woolen, aqueous susp' 21ppm. ozone, R.H. 68%, temp. 20.5 C.		Elford	1942
exposed 30 minutes	--------------------		
exposed 60 minutes	--------------------		
exposed 90 minutes	--------------------		
Serge, woolen, aqueous susp. .06 ppm. ozone, R.H. 89%, 21 C., exposed 45 min.	95% killed	"	"
GLASS			
Glass, aqueous susp'n, R.H. 68%, 20.5 C., 21ppm ozone			
exposed 30 min.	>99% killed on surface	Elford	1942
exposed 60 min.	>99% killed on surface		
exposed 90 min.	>99% killed " "		
Glass, aqueous susp'n, R.H. 89%, 21C., .06 ppm ozone, exposed 45 minutes.	-----killed		
Petri dishes, empty, sterile room temperature	24 hrs.	Kirstein	1902
Slides, sterile, 37C., innoc innumerable colonies	None recovered, 28 hrs.	Teague	1913
Glass slides, 37 C., innoc. 1,900	Recovered 3, 40 min.	Norton	1931
Glass, sunlight	2 minutes	Weinzirl	1907
Glass, 37 C., innoc.110,000 at 30 sec.	Recovered none, 10 min.	Bryan	1933
PAPER			
Aqueous susp'n, 21 ppm. Ozone, R.H. 68%, 20.5 C.,			
exposed 30 min.	98% killed	Elford	1942
exposed 60 min.	99% killed		
exposed 90 min.	>99% killed		
Aqueous susp'n, 0.06 ppm. ozone, R.H. 89%, 21 C., exposed 45 min.	98% killed	"	"
Filter paper, surface, inoc. 150	Recovered none, 20 min.	Norton	1931
Filter paper, moist, inoc. 960	Recovered none, 30 min.		
Filter paper, inoc. 4,000	Recovered 40, 30 min.	"	"
Filter paper, surface of, inoc. 1,000	Recovered 6, 30 min.		
Filter paper, moist, innoc. 320	Recovered 1,000 at 30 minutes	"	"
Filter paper, inoc., 3,500	Recovered 310 at 30 min	"	"
Paper, surface, inoc. 230, colonies on agar plates	Recovered none at 2 min	Norton	1932
Paper, sunlight	2-10 minutes	Weinzirl	1907
Filter paper, moist, inoc. 500,000, 37C.	Recovered 141,000 at 15 minutes	Bryan	1933

TABLE [illegible]

THE SURVIVAL OF SHIGELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
S. dysenteriae			
Dust	10 days	Kister	1928
FABRICS			
S. dysenteriae			
Hemp	Several days	Lentz	(?)
Clothes	24 days		
Leinwand	17 days		
Clothes, dried on			
R.T., dark,	150 days	Winter	1912
37 C.	11 days		
R.T., diffuse daylight	20 days		
Sheep's wool, R.T.	106 days	Karlinski	1907
Cloth, 17-20 C.	4-9 days	Frost	1905
Cloth, 38 C.	Only 1/2- 1/4 survive of those at 17-20 C. (Shiga more frail than Flexner)		
Dried on linen	30 days	Dold	1943
Linen, scraps, feces on,			
diffuse light, R.T.	79 days	Karlinski	1907
dried in sun	1/2 hr.		
on bed straw, 15-21 C.	38 days		
Cloth, dried	None recovered, 22 days	Pfuhl	1902
Soiled washing, R.T., dark dried on linen	30 days	Dold	1944
S. paradysenteriae (Flexner)			
Cotton-wool swab, inoc. 7,200 cols.		Rubbo	1951
plain, dry	0 at 8 hrs.		
plain, moist	5-20 cols. at 24 hrs.		
serum, dry	5-20 cols. at 24 hrs.		
serum, moist	20-50 cols. at 48 hrs.	"	"
Dried on linen, S. sonnei survive 2-3 times longer than Flexner strain		Dold	1943
S. spp.			
Dried on linen, R.T., dark	5-46 days	Roelcke	1938
Linen, dried on, R.T., dark	5-46 days	Vaillard	1903
Linen, alc. & ether, chloroform, 37 C.	Few hours		
Linen, dessication	20-25 days	"	"
S. sonnei			
Dried on linen, S. sonnei survives 2-3 times longer than Flexner strain		Dold	1943
PAPER			
S. dysenteriae			
Paper, 17-20 C.	4-9 days	Frost	1905
Paper, 38 C., will live 1/2-1/4 surv. of those at 17-20 C.--Shiga more frail than Flexner.			
Filter paper, dried with Flexner	113 days	Dold	1947
Filter paper, dried, stool	1-2 wks.	Joe	1950

TABLE Su 15 (CONT'D) THE SURVIVAL OF SHIGELLA SPECIES ON SURFACES

Factor(s)	Survival	Reference	
PAPER(CONT'D)			
S. paradysenteriae			
Filter paper, dried	270 days	Dold	1947
S. spp.			
Paper sunlight	5 min	Weinzirl	1907
WOOD			
S. dysenteriae			
Wood, 17-20 C	4-9 days	Frost	1905
Wood, at 38 C., org. will live only 1/2-1/4 surv. of those at 17-20 C.. Shiga more frail than Flexner			
GENERAL			
S. dysenteriae			
Bread, surface of after baking	30 hrs.	Alves	1935
Crust of rye bread in well- ventilated room at R.T., with strains of Flexner and Sonnei	45 days	Bachmann	1943
Same as above only at lower temperature -5to -25 C.	2 mos.	"	"
S. paradysenteriae (Flexner)			
Bread, surface, after baking	30 hrs.	Alves	1935
Crust of rye bread, in well ventilated room at R.T., with Shiga and sonnei, At lower temps. -5 to - 25 C.	45 days	Bachmann	1943
	2 mos.	Bachmann	1943
S. sonnei			
Crust of rye bread, in well ventilated room at room temp., with Flexner strains and dysenteriae	45 days	"	"
At lower temp -5 to -25C.	Longer than 2 mos.	"	"

TABLE Su16

THE SURVIVAL OF STREPTOCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
S. pyogenes (group A)			
Dry sweeping, 38 samples	73.8% (10,000-1 mill.) 26.2% (150-10,000)	Hamburger	1944
Dry sweeping of scarlet fever ward, 47 samples	4.3%--0 63.9% (1,000-10,000) 29.7% (10,000- 1 mill.) 2.1% (over 1 million)	"	"
Sweeping of compound, 49 samples	52% (0) 42% (150-10,000) 6% (10,000- 1 million)	"	"
Dust, strain 1, R.T.	44 days	Laurell	1949
Floor dust, type 3	Many recovered, 4 days	Lemon	1944
Dust, description of tonsillitis in person who swept out cubicle previously occupied by pueperal sepsis case.	25 days	White	1936
Floor dust, 4 strains of Group A recovered--three different methods--sweeping, vacuum cleaner and blowing.	20%-67% recovered	Williams	1949
FABRICS			
S. pyogenes (group A)			
Cotton wool swab, strept. throat, 17-19 C., inoc. >50 colonies, plain swab	21 colonies at 48 hrs.	Rubbo	1951
serum swab	27 colonies at 48 hrs.		
Absorbent wool, plain, swabs, 17-22 C., inoc. > 200 cols., Plain dry	20-50 cols. at 48 hrs.	"	"
Plain moist	5-20 cols. at 8 hrs.		
Non-absorbent wool, 17-22 C., inoc. > 200 cols. plain dry	50-200 cols. 48 hrs.	"	"
plain moist	20-50 cols. 48 hrs.		
Absorbent wool, serum, dry	50-200 cols. 48 hrs.		
Absorb. wool, serum, moist	50-200 cols. 48 hrs.		
Cotton-wool swab., 16-22C. plain, dry	5-20 cols. at 48 hrs.	"	"
plain, moist	5-20 cols. at 8 hrs.		
serum, dry	50-200 cols. at 48 hrs.		
serum, moist	50-200 cols. at 48 hrs.	"	"
Bedding, type 3	Many recovered, 4 days	Lemon	1944
Blankets	Survive > 4 months	Robertson	1944 1947
Blankets, glycol vapor	70% reduction		
Blankets, oiled, 2% mineral oil emulsion	90% reduction	"	"
Blanket, oiled, exposed 5 min. after & during heating	170 colonies	Andrewes	1940

TABLE IV 16 (CONT D) THE SURVIVAL OF STREPTOCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS (CONT'D)			
S. pyogenes (group A)			
Blanket, unoiled	1030 colonies	Andrewes	1940
Blankets oiled	26 out of 307 cultures were positive	Dingle	1946
Blankets, unoiled, (441)	160 positive, 50% of these were Group A and remainder largely group C & B	"	"
Cotton, R.T., strains 1, 2, 3, dried	> 53 days	Laurell	1949
Linen, R.T., strains 1, 2, 3, 4, dried	> 53 days		
Wool, R.T., strains 1, 3, 4, dried	> 53 days	"	"
Blanket, 70-85 F., R.H. 25-30%, 10 blankets pos. at beginning.	Only 1 positive, 7 mos.	Loosli	1948
Overcoat, wool blouses & towels, envir. temp.	At least 4 days	"	"
Toweling, dry	Alive at end of 48 hrs.	Pease	1930
Blankets, sucked from, no. 47, ENT ward, along with M. aureus, E. coli & others	14,400-7,344,000/cu.ft. of air.	Rountree	1946
Oiling of blankets, bed linen, & garments	Reduces no. of bacteria in air during bed making; 91-98% below those in control ward	Cruickshank	1947
Rate lower in oiled ward	18.6% versus 73.3%.	"	"
In air, floor dust, & bed clothings of hospital wards		Hamburger	1944
S. pyogenes (Group B)			
Blankets, beaten, strep. plate count. 0 hour	2000/ plate	Van den Ende	1940
24 hrs.	701/ plate		
10 days	294/plate		
4 weeks	98/plate		
very slight reduction in virulence in 4 weeks		"	"
S. pyogenes (Group C)			
Blankets, 2 ft. above floor, 10min. after beating	426/plate	"	"
S. viridans			
Cotton-wool swab, 16-22 C., plain, dry	5-20 cols. at 48 hrs.	Rubbo	1951
plain, moist	20-50 cols. at 24 hrs.		
serum, dry	50-200 cols. at 48 hrs.		
serum, moist	50-200 cols. at 48 hrs.	"	"

TABLE Su/6 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference	
FABRICS(CONT'D)			
S. spp.			
Serge, sprayed, medicinal paraffin, mechanically beaten, 1st 2 min.; during 5 min. period, 12 to 17 min. after beating	Recovered 1300 Recovered 900	Van den Ende	1941
Woolen blanket, beaten, during 1st 2 min.; during 5 min. period, 12-17 min. after beating	Recovered 4000 Recovered 2500	"	"
Wool blanket, dry strep. during 1st 2 min.; during 5 min. period, 12-17 min. after beating	Recovered 490 Recovered 11	"	"
Cotton sheet, dry strep. during 1st 2 min.; during 5 min. period 12-17 min. after beating	Recovered 508 Recovered 24	"	"
Cotton, sprayed strept. during 1st 2 min.; during 5 min. period 12-17 min. after beating.	Recovered 1320 Recovered 232	"	"
Blankets, clothing	"month or more"	Pulvertaft	1947
Blankets, application of crude liquid paraffin before sweeping floors, greatly reduces contamination at 5 ft. level and 2 ft. level.		Van den Ende	1940
GLASS			
S. pyogenes			
Sterile dishes	50-90%	Wood	1939
Soiled dishes	6-20%		
Petri dishes, org. in. on floor, dark; diffuse light	20% alive, 14 days <1% alive, <7 days	Phelps	1939
Glass, Susp'n Cont. / Exp. time in min.		Burtenshaw	1938
339.2 / 105	10.2 washed off		
583.2 / 10	35.2 " "		
720 / 85	6.2 " "		
852 / 6	54.4 " "	"	"
1270 / 5	45 " "		
1542.4 / 84	23.3 " "		
1971.2 / 3	132.2 " "		
2329.6 / 4	14.6 " "		
2880 / 6	328.6 " "		
S. viridans			
Ground glass, deposited & allowed to dry. Discrete colonies when surfaces are embedded in a nut. agar medium.	Also used to determine effect of atmos. Hum. on survival of bacteria on glass surfaces.	Annear	1951

TABLE Au16 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES ON SURFACES

Factor(s)			Survival	Reference	
GLASS(CONT'D)					
S. salivarius					
Glass, serum broth, R.H. 65%, 0.21ppm. ozone, 20C. exposed 90 min.,			97% killed	Elford	1942
Glass, serum broth, R.H. 82%, 18C., exposed 75min.			>99% killed		
Glass, serum, 0.12ppm. ozone, R.H. 84%, 20 C., exposed 60 min..			>99% killed		
Glass, serum, 0.18 ppm. ozone, R.H. 80%, 20 C., exposed 90 min			>99% killed	"	"
PAPER					
S. salivarius					
Paper, serum broth, R.H. 65%, 20C. 0.ppm. ozone, exposed 90 min.			48% killed	Elford	1942
Paper, serum, R.H. 82%, 18 C., 0.21ppm. ozone, exposed 75 min.			99% killed	"	"
Paper, serum, 0.12ppm. ozone, R.H. 84%, 20C. exposed 60 min.			85% killed	"	"
Paper, serum, 0.18 ppm. ozone, R.H. 80%, 20C., exposed 90 min.			54% killed	"	"
S. pyogenes					
Paper, R.T., strain 1, dry			44 days	Laurell	1949
RUBBER					
S. pyogenes(hemolyticus)					
Rubber apron,				Burtenshaw	1938
	Susp'n cont.	Exp. time in min.	No. washed off		
	339.2	105	2.1		
	583.2	9	12.0		
	720	85	7.1		
	852	6	35.3		
	1270.4	4	9.6		
	1542.4	80	.4		
	1971.2	4	4.8		
	2329.6	5	6.1	"	"
	2880	5	295.7		
Rubber condom,	Susp'n cont.	Exp. time in min.	No. washed off	"	"
	339.2	105	5.3		
	583.2	10	18.2		
	720	85	27.0	"	"
	852	6	38.2		
	1270.4	4	65.0		

TABLE Su 16 (CONT'D) THE SURVIVAL OF STREPTOCOCCUS SPECIES ON SURFACES

Factor(s)	Survival	Reference
RUBBER (cont'd)		
S. pyogenes		
Rubber condom, Susp'n cont. / Exp time in min.	No. washed off	Burtenshaw 1938
1542.4 / 78	40.2	
1971.2 / 4	93.6	
2329.6 / 5	175.7	" "
2880 / 5	360.1	
UTENSILS		
S. faecalis		
Utensils	High %	Hutchinson 1947
S. viridans		
Utensils	High %	" "
GENERAL		
S. pyogenes		
Mouthpiece of telephone	4-11 days	Coulter 1937
Metal from bullet lodged in flesh of soldier	>2 mos.	Pulvertaft 1929
S. salivarius		
Hand telephone	72.92%	Smeall 1937
Telephone with separate receiver and transmitter	11.10%	" "
S. mitis		
Hand telephone	68.75%	" "
Telephone with separate receiver and transmitter	3.70%	
S. non-hemolyticus		
Hand telephone	2.10%	" "
Telephone with separate receiver and transmitter	3.70%	
S. equine		
Hand telephone	12.50%	" "
S. ignavus		
Hand telephone	8.33%	
S. faecalis		
Hand telephone	2.10%	" "

TABLE Su12 THE SURVIVAL OF VIRUSES ON SURFACES

Factor(s)	Survival	Reference	
DUST			
Foot & Mouth disease			
Stable dust, 62 F., 52% R.H.	11 days	Burbury	1928
Influenzae virus			
Dust, drying, inoc. 1X10^4	Recovered none, 3 wks.	Edwards	1941
Dust, soaked virus susp'n, R.T., dried	Between 1%-10% recovered in 1 wk.	Krueger	1942
Dust, [illegible]	Long periods	Pulvertaft	1947
FABRICS			
Influenzae virus			
Sheet, dried, 22C.	> 3 days	Edwards	1941
Sheet, dried, 37C.	<24 hrs.		
Sheet, dark, dried	1 wk.		
Sheet, light, dried	<3 days		
Sheet, 22 C., inoc. 0.1cc	Recovered none, 7 days	"	"
Sheet, 37 C., inoc. 0.1cc	Recovered none, 24 hrs.		
Sheet, treated with infected saliva.	1 month		
Blanket, dried, inoc. 5% susp'n.	>5 hrs.	"	"
Blanket, sterile, ord. atmos. conditions	Survives drying	Krueger	1942
Sheeting, serge, soaked with virus susp'n., dried R.T.	Between 1%-10% recovered in 1 wk.	"	"
Fabric	Survived for many days	Robertson	1945
Newcastle virus			
Burlap strips, 4, 22, & 36 C., treated with organic mercurial cpds.	Survived for over 50 days	Jungherr	1950
Cotton cloth, inoc. 0.2ml. of 1;10 dilution,			
37 C.	16 days	Olesuik	1951
20-30 C.	52 days		
11-36 C.	145 days		
3-6 C.	193 days		
-26 C.	538 days		
Burlap, inoc. 0.5ml.			
37 C	14 days	"	"
20-30 C.	16 days		
11-36 C.	108 days		
3-6 C.	123 days		
-26 C.	538 days		
GLASS			
Foot & Mouth virus			
Glass, dried on, R.T., kept chem. dry	2 years	Burbury	1928
Glass, dried on, 62 F., 52% humidity	10 days		
Glass slides, dried on, exposed to August sun.	1 hr.	Topley	1946

TABLE 17 THE SURVIVAL OF VIRUSES ON SURFACES

Factor(s)	Survival	Reference	
GLASS(CONT'D)			
<u>Influenzae virus</u>			
Glass, dried on surface, R.T.	Still positive 40 min. after drying	Anon.	1943
Glass, dried	1x 10^6 was reduced to <1x10^2 in 6 weeks	Edwards	1941
Glass, dried, 0.1cc inoc.	Recovered none		
Glass, 22 C.	>4 weeks	"	"
Glass, 37 C.	<1 week		
Glass slides soaked with virus suspin., dried, kept at R.T.	Between 1% - 10% recov. in 1 wk.	Krueger	1942
<u>Newcastle disease virus</u>			
Glass, refrig. temp.	Active many months	Asplin	1949
<u>Smallpox virus</u>			
Diluted vesicle fl. dried on glass slides, dark	84 days	Downie	1947
daylight	35 days		
<u>Filterable virus</u>			
Film on glass slide	Retain virulence 15 mos.	Burnet	1906
PAPER			
<u>Foot & Mouth virus</u>			
Paper, 62 F., 52% R.H.	2 days.	Burbury	1928
<u>Newcastle disease virus</u>			
Filter paper, exposed to dry cond., 98 F.	Inactive after 12 hrs.	Asplin	1949
Paper, refrig. temp.	Active many months		
Filter paper, inoc. 0.2ml			
37 C.	28 days	Olesuik	1951
20-30 C.	25-49 days		
11-36 C.	129 days		
3-6 C.	157 days		
-26 C.	538 days		
RUBBER			
<u>Influenzae virus</u>			
Rubber, R.T.	40 min. after drying still positive	Anon.	1943
GENERAL			
<u>Foot & Mouth virus</u>			
Temp. 3.5 & 5.5 C., if kept moist	6 months	Traum	1934
R.T., dried rapidly in a vacuum	105 days		
On infected premises	345 days	"	"
<u>Tobacco mosaic virus</u>			
Cured tobacco leaves	31 years	Valleoy	1927
<u>Small pox virus</u>			
Crusts	" many years"	Pulvertaft	1947
<u>Swine-fever virus</u>,			
Bricks autoclaved, dried	3 days	Slavin	1930
Hay, autoclaved, dried	3 days		
Virus destroyed in 15 min	by 5% soln. pure phenol and hypochlorite, 1.66 % available chlorine.	Slavin	1938

TABLE Su17 (CONT'D) THE SURVIVAL OF VIRUSES ON SURFACES

Factor(s)	Survival	Reference
GENERAL(CONT'D)		
Influenzae virus (Melbourne)		
Talc, dried with, original titer 10^{-3}	Recovered none, 22 days	Parker 1944
Mucin in air, dried with, orginal titer 10^{-4}	Recovery positive in 45 days	

TABLE Su18

THE SURVIVAL OF YEAST, MOLDS AND FUNGI ON SURFACES

Factor(s)	Survival	Reference	
DUST			
Molds			
Dust in air during dust storm	Dust counts yielded unusually high counts	Proctor	1935
FABRICS			
Trichophyton interdigitale			
Woolen jersey	2 months	Gould	1931
Trichophyton gypseum			
Cotton string and linen	Several months, at least 102-346 days	Shaw	1944
Microsporon audouni			
Cotton string	At least 78-276 days		
Microsporon lanosum			
Cotton string	At least 102-235 days		
Fungi spores			
Clothing, spores carried	------------------	Smith	1943
PAPER			
Trichophyton gypseum			
Filter paper	Several months, at least 102-346 days	Shaw	1944
Molds			
Cardboard strips, spores ultra-violet light	None entirely killed	Appling	1941
Yeasts			
Whatman # 50 paper, water susp'n. sprayed, 15 min. exposure to short waves	50 % killed	Lion	1949
GENERAL			
Microsporon audouini			
Hair planted on Sabouraud	420 days	Farley	1921
Fungi			
Hand tele phone	5.25 % organism	Smeall	1937
Molds			
Hand tele phones	20.83% organisms	Smeall	1937
Telephones with separate receiver and transmitter	11.10% organisms	Smeall	1937
Yeast			
Hand telephones	47.92%	"	"
Telephones with separate receiver and transmitter	11.10%		

References (Surfaces)

1. Abel, T. 1893 Beitrag zur Frage von der Lebensdauer die Diphteriebacillen. Centr. Bakt., 14, 756-761.
2. Abel, T. 1895 Versuche über das Verhalten der Diphterr-bacillen gegen die Einwirkung der Winterkälte. Centr. Bakt., I Abt. (Orig.), 17, 545-550.
3. Abel, R. 1897 Zur Kennthnis des Pestbacillus. Centr. Bekt. 21, 497-517.
4. Albert, J.O., Long, H.F., and Hammer, B.W. 1944 Classification of the organisms importent in dairy products. lV. Bacterium Linens. Agric. Exp. Station Iowa State College of Agriculture and Mechanic Arts., Bull. No. 328.
5. Alves, W. 1935 Unwrapped bread and intestinal bacteria. S. African Med. J., 9, 191-192.
6. Andrewes, C.H. 1940 Control of aie-borne infection in air-raid shelters and elsewhere. Lancet, 2, 770.
7. Annear, D. 1951 The inoculation, cultivation and enumeration of bacteria on glass surfaces. Methods for disinfection studies. Australian J. Exp. Biol. Med. Scil, 29, 147-151.
8. Anonymous 1921 Minist. Health Circ., No. 172.
9. Anonymous 1933 Rep. New York State Vet. Coll, 1931-1932, No. 18.
10. Anonymous 1943 The inactivation by human skin of influenza virus in the presence of saliva. U.S. Naval Med. Bull., 41, 692-697.
11. Appling, J.W. 1945 The bacteriological examination of paper. Paper Trade J., 120, 34-40
12. Appling, J.W., and Tanner, F.W. 1941 Bactericidal effect of ultraviolet rays (sterilamp) on microorganisms on restaurant glassware. Proc. Soc. Exp. Biol. Med., 47, 51-54.
13. Arguelles, M.V. 1927 Viability of cholera vibrio in various menstrua. Rev. Filipina de Med. y Farm., 18, 137-140.
14. Asplin, F.E. 1949 Observations on the viability of Newcastle disease virus. Vet. Rec., 61, 159-160.
15. Bachmann, W., and Lodenkämper, H. 1943 Versuche ueber die Lebensfähigkeit von Erregern der bakteriellen Ruhr bei Verwendung von Brot als Keimträger. Arch. Hyg. Bakt., 130, 77-84.
16. Berckholz, N.I. 1889 Untersuchungen über den Ein flub des Eintrocknens auf die Lebensfähigkeit der Cholerabacillen. Arbeit. aus dem Kaiserl. Gesundh., 5, 1-36.
17. Blanc, G., and Baltazard, M. 1940 Longevity of virus of murine typhus in excrements of infected fleas. Bull Soc. Path. Exot., 33, 25-32.
18. Blumenberg, W. 1937 Danger of bacterial infection from food contained in damaged China ware. Z. Hyg., Infektionskrankh., 120, 87-102.

19. Breinl, F., and Hofmann, R. 1935 Uber Sterilisationsleistung bewegter Heissluft. A rch. Hyg. Bakt., 113, 305-312.
20. Bryan, C.S., and Mallman, W.L. 1933 Some factors responsible for the so-called self-disinfecting power of the skin. J. Lab. Clin. Med., 18, 1249-1255.
21. Buchbinder, L., and Solotorovsky, M. 1941 Studies on microorganisms in simulated room environments. VI. The disappearance of Vaccinia virus from the air. J. Bact., 42, 635-641.
22. Buckley, G.G. 1906-1907 The resistance of some pathogenic microbes to drying. Pub. Health, London, 19, 290-298.
23. Burbury, Y.M. 1928 Survival of the (foot-and-mouth disease) virus outside the body. Ann. Appl. Biol., 15, 139-142.
24. Burnet, N.I. 1906 (see McCulloch, E.C., 1945).
25. Burtenshaw, J.M.L. 1938 Mortality of Streptococcus hemolyticus on skin and other surfaces. J. Hyg., 38, 575-586.
26. Cameron, H.S. 1933 Rep. New York State Vet. Coll., 1931-1932, No. 18.
27. Cathcart, W.H., Ryberg, R.E., and Merz, A. 1942 Staphylococci and Salmonella control in foods; effect of ultraviolet radiation and ozone on bakery custard and cream fillings. Food Research, 7, 1-9.
28. Chatin, P., and Rochaix, A. 1926 Persistance of tubercle bacillus in Braille books. Compt. rend soc. biol., 94, 527-528.
29. Cherkasskii, E.S. 1938 Disinfection of "Brucella wool". Sherstyanoe Delo., 17, 24-28.
30. Chick, H. 1900-1901 The distribution of Bacterium coli commune. Thompson Yates Lab. Rep., 3, 1-29, 117-129.
31. Coulter, C.B., and Stone, F.M. 1937 Bacteriologic survey of telephone instruments under various conditions of use. Am. J. Pub. Health, 27, 993-1002.
32. Cruickshank, R., Et Al 1947 Discussion: Modern methods in control of air-borne infections. Proc. Roy. Soc. Med., 40, 381-383.
33. Dingle, J.H., Abernathy, T.J., Badger, G.F., Beard, J.W., Cressy, N.l., Feller, A.E., Gordon, I., Langmuir, A.D., Rammelkamp, C.H., Jr., Strauss, E., and Tatlock, H. 1946 A study of the effect of oiled floors and bedding on the incidence of respiratory disease in new recruits. Am. J. Hyg., 43, 120-144.
34. Dold, H. 1944 Danger of infection from "washing" soiled with organisms of typhoid-paratyphoid-dysentery group. Bull. War Med., 5, 132.
35. Dold, H., and Hsiang, C.Y. 1919 Uber das Verhältnis der Tatsächlichen zur theoretisch Möglichen gefahr der Keimübertragung durch Fingerberührungen. Z. Hyg. Infektionskrankh. Kr., 89, 266-284.
36. Dold, H., and Ketterer, M. 1944 Comparative studies on survival time of bacteria of typhoid-paratyphoid-enteriditis group and dysentery group in liquid fecal matter and in feces dried on filter paper. Z. Hyg. Infektionskrankh. 125, 444-456.
37. Duguid, J., and Wallace, A. 1948 Air infection with dust liberated from clothing. Lancet, 255, 845-849.

38. Dumbell, K.R., and Lovelock, J.E. 1949 Handkerchiefs in the transfer of respiratory infection. Lancet, 256, 777-780.
39. Dumbell, K.R., Lovelock, J., and Lowbury, E. 1948 Handkerchiefs in the transfer of respiratory infection. Lancet, 255, 183-185.
40. Ecklund, A.W. 1932 Viability of diphtheria bacilli on knife blade. Lancet, 52, 355-356.
41. Edwards, D.G. 1941 Resistance of influenza virus to drying and its demonstration on dust. Lancet, 241, 664-665.
42. Elford, W.J., and Van den Ende, J. 1942 An investigation of the merits of ozone as an aerial disinfectant. J. Hyg., 42, 240-265.
43. Elford, W.J., and Van den Ende, J. 1945 Disinfecting action of hypochlorous acid gas and sprayed solution of hypochlorite against bacterial aerosols. J. Hyg., 44, 1-14.
44. Elser, W.J., and Huntoon, F.M. 1909 Studies on meningitis. J. Med. Research, 20, 377-541.
45. Ficker, M. 1898 Ueber Lebensdauer und Absterben von Pathogenen Keimen. Z. Hyg., 29, 1.
46. Farley, D.L. 1921 Viability of ringworm fungi in dry cutaneous material. Arch. Dermatol. Syphilol., 3, 759.
47. Flügge, C. 1905 Die in Hygienischen Institut der Königl Universität Breslau wahrend der Genickstam-epidemic im Jahre 1905. Ausgefuhrten Untersuchungen. Klinisches Jahrubuch, 15, 353-372.
48. Francis, E., and Lake, G.C. 1922 Experimental transmission of tularemia in rabbits by the rabbit louse, Haemodipsus ventrilosis (Denny). U.S. Pub. Health Ser. Bull., No. 130.
49. Frank, B. 1943 Bakterien auf Türklinken. Arch. Hyg., 131, 176.
50. Frantsev, A.V. 1935 Stuffing boxes of pumps as sources of B. coli in tap water. Grease as source of carbon for B. coli. Microbiologiia, 4, 655-659.
51. Frost, W.D., and Whitman, R. 1905 The viability of B. dysenteriae Shiga. Science, 21, 483.
52. Gage, S. de M. 1903 On the relative viability of B. coli and B. typhosus under certain conditions. Science, 17, 379.
53. Galli-Valerio, B. 1914 The use of ozone for disinfection of air. Centr. Bakt. Parasitenk., Abt. 1, 75, 93-96.
54. Gamaleia, P.N. 1893 Ueber das Leben der Cholerabacillen im Wasser unter dem Einflusse des Eintrocknens und der Feuchtigkeit. Deut. Med. Wochschr., 19, 1350-1353.
55. Gladin, G.P. 1898 Die Lebensfähigkeit der Pestbacillen unter verschieden physikalischen Bedingungen und der Einwirkung von Desinficientien. Centr. Bakt., 24, 588-591.
56. Gould, A.G., and Carter, E.K. 1931 Viability of pathogenic fungus on wool cloth. Am. J. Hyg., 14, 694-697.
57. Graham-Smith, G.S. 1930 Longevity of dry spores of anthrax bacilli. J. Hyg., 30, 213-215.
58. Graham-Smith, G.S. 1941 Longevity of dry anthrax spores; further observations. J. Hyg., 41, 496.
59. Habs, H., and Ehrmeier, A. 1933 Clothing of unemployed and transmission of undulant fever. Deut. Med. Wochschr., 59, 1400-1402.

60. Hamburger, M.J., Puck, T.T., Hamburger, V., and Johnson, M. A. 1944 Studies on the transmission of hemolytic streptococcus infections. IV. Hemolytic streptococci in the air, floor dust, and bedclothing of hospital wards and their relation to cross infection. J. Infectious Diseases, 75, 79-94.
61. Hellat, A. 1948 Studies on the self-disinfecting power of the skin. Ann. Med. Exp. Ciol. Fenn, 26, 1-95.
62. Hewlett, R.T. 1909 Disinfection and disinfectants. Lancet, 1, 741, 815, 889.
63. Hewlett, R.T. 1939 Tolerance of phenol vapour. Lancet, 1, 664, 1126-1127.
64. Hite, K.E., and Dack, G.M. 1938 Survival of Clostridium sporogenes, Bacillus subtilis, and Staphylococcus albus on surgical (catgut) ligatures. Surgery, 4, 548-551.
65. Hoare, E.D., O'Brien, J.R., and Watkins, A.G. 1943 Dust as vehicle of infection in children's wards. Lancet, 2, 666-667.
66. Hutchinson, I. 1947 Food utensil bacteriology. Brit. Med. J., 4490, 134-135.
67. Ignatovich, Z.A., and Gokhberg, R.B. 1934 Determination of bacteria on external surface of bread. Sovet. Vrach. Gaz., 1812-1816.
68. Jacobs, M.A., and Petroff, S.A. 1944 Occurrence of tubercle bacilli on garments handled by patients with open tuberculosis. Nova Scotia Med. Bull., 23, 134-139.
69. Jettmar, H.M. 1927 Investigations of the vitality of Vibrio cholerae on Chinese paper money. Nat. Med. J. China, 13, 254-260.
70. Joe, L.K. 1950 Een eenvoudige, goedkope en doeltreffende methode voor verzending van dysenterie-, typhus- en paratyphusfaeces naar het laboratorium. Nederland. Tijdschr. Geneesk., 94, 1246-1254.
71. Jungeblut, C.W. 1935 Epidemic meningitis. Agent of disease and host resistance. Frederick P.Gay, Springfield.
72. Jungherr, E. 1950 Studies on sanitizing used feed bags. J. Am. Vet. Med. Assoc., 117, 324-328.
73. Karlinski, J. 1907 Ueber Serotherapie der Ruhr. Wiener Klin. Wchn., 1906, 19, 1550.
74. Kennedy, N.I. 1905 Rep. Comm. Meditterranean Fever, Part III, 71.
75. Kessel, J.F., and Thompson, C.F. 1950 Survival of Trichomonas vaginalis in vaginal discharge. Proc. Soc. Exp. Biol. Med., 74, 755-758.
76. Kirstein, F. 1902 Z. Hyg. Infektionskrankh., 39, 163.
77. Kirstein, F. 1905 Ueber die Dauer der Lebensfahrigkeit von Tuberkelbacillen an flugfahrigen Staubchen. Z. Hyg. Infektionskrankh., 50, 186-214.
78. Kister, J. 1928 Verbreitung von Typhus durch Abfallstoffe. Arch. Hyg., 100, 1-4.
79. Kitasato, S. 1889 Die Widerstandfahigkeit der Cholerabacterien gegen das Eintrocknen und gegen Hitze. Z. Hyg. Infektionskrankh Parasitenk., 5, 134-140.
80. Kitasato, S. 1894 The bacillus of bubonic plague. Lancet, 2, 428-430.

81. Krueger, A.P., Hope, J.W., Rosenberg, L.R., and West, N.S. 1942 Inactivation of influenza virus by human skin. U. S. Nav. Med. Bull., 40, 839-846.
82. Kusama, H. 1925 Viability of Bacillus dysenteriae. Philippine J. Sci., 27, 1-7.
83. Kutscher, K. 1906 Ueber Unterschungen der Nasenrachenhöhle gesunder Menschen auf Meningococcen. Deut. med. Wochschr., 32, 1071-1075.
84. Laurell, G. Lofstrom, G., Magnusson, J. and Ouchterlony, O. 1949 Airborne infections. II. A report on the methods. Acta. Med. Scand., 134, 189-204.
85. Lehmann, K.B. 1931 Das Absterben von Eiterkokken auf Linoleum Holz, Glas, und Gummi unter Berücksichtigung von Licht und Temperatur. Arch. Hyg., 106, 1-31.
86. Lemon, H.M., Wise, H., and Hamburger, M., Jr. 1944 Bacterial content of air in army barracks. Results of a study with especial reference to the dispersion of bacteria by the air circulation system. War Medicine, 6, 92-101.
87. Lentz, N.I., and Prigge, N.I. Kolla, Kraus, Uhlenhuth, 3, 1404-1405.
88. Lion, K.S., and Gould, B.S. 1949 Effect of high frequency electric fields on some microorganisms. Am. Brewer, 82, 21-24.
89. Lipman, C.B. 1934 Further evidence on amazing longevity of bacteria. Science, 79, 230-231.
90. Lomry, P. 1929 Survival of diphtheritic and typhoid-paratyphoid bacilli outside of body. Compt. rend. soc. biol., 101, 482-483.
91. Loosli, C.G., Lemon, H.M., Wise, H., and Robertson, O.H. 1948 Studies on the transmission and control of respiratory disease within army barracks. J. Infectious Diseases, 82, 59-71.
92. Loosli, C.G., Wise, H., Lemon, H.M., Puck, T.T., and Robertson, O.H. 1946 The oil treatment of bedclothes for the control of dust-borne infection. Am. J. Hyg., 43, 105-119.
93. Lorentz, F.H. 1924 Die Hinfälligkeit der Gonokokken. München. Med. Wochnschr., 71, 173.
94. Luckiesh, M., Taylor, A.H., Knowles, T., and Leppelmeier, E.T. 1949 Inactivation of molds by germicidal ultraviolet energy. J. Franklin Inst., 248, 311-325.
95. McKhann, C.F., Carlson, H.J., and Douglas, H. 1948 Oligodynamic action of metallic elements and of metal alloys on certain bacteria and viruses. I. In vitro observation. J. Pediat., 2, 272-289.
96. Mackie, T.J., and McCartney, J.E. 1934 An introduction to practical bacteriology. 4th Ed., Edinburgh.
97. MacNabb, A.L., White, F., and Owen, O.W. 1938 Bacteriological study of eating and drinking utensils. Can. Pub. Health J., 29, 591-599.
98. Mayser, H. 1925 Zur Kenntnis der Keimfreimachung von Gegenständen mit Spiritus. Centr. Bakt., Abt. 1, Orig., 94, 238-240.
99. Migneco, N.I. 1895 Arch. Hyg., 25, 361.

100. Miller, C.P., and Schad, D. 1944 The resistance of meningococci to drying. J. Bact., 47, 71-77.
101. Miller, C.P., and Schad, D. 1944 Germicidal action of daylight on meningococcus in the dried state. J. Bact., 47, 79-84.
102. Minett, F.C. 1950 Sporulation and viability of B. anthracis in relation to environmental temperature and humidity. J. Comp. Path. Therap., 60, 161-176.
103. Murray, E.G.D., and Denton, G.P. 1949 Plaster of Paris as a source of infection in tetanus and gas gangrene. Canadian Med. Assoc. J., 60, 1-4.
104. Norton, J.F., and Novy, M.F. 1931 Studies on the self-disinfecting power of the skin. Am. J. Pub. Health, 21, 1117.
105. Norton, J.F., and Novy, M.F. 1932 A further note on the disappearance of bacteria applied to the skin. Am. J. Pub. Health, 22, 193.
106. Olesiuk, O.M. 1951 Influence of environmental factors on viability of Newcastle disease virus. Am. J. Vet. Research, 12, 152-155.
107. Oliphant, J.W., Gordon, D.A., Meis, A., and Parker, R.R. 1949 Q fever in laundry workers, presumably transmitted from contaminated clothing. Am. J. Hyg., 49, 76-82.
108. Olson, T.A., and Rueger, M.E. 1950 Experimental transmission of Salmonella oranienburg through cockroaches. Pub. Health Repts., 65, 531-540.
109. Osler, W. 1901 Practice of Medicine (4th Ed.).
110. Ouchterlony, O. 1949 Airborne infections. III. Infections and spreading of infection in diphtheria with special reference to isolation wards. Acta. Med. Scand., 134, 296-309.
111. Parker, E.R., Dunham, W.B., and MacNeal, W.J. 1944 Resistance of the Melbourne strain of influenza virus to desiccation. J. Lab. Clin. Med., 29, 37-42.
112. Paul, T., and Prall, F. 1907 Die Wertbestimmung von Desinfektionsmitteln mit Staphylokokken, die bei der Temperatur der flüssigen Luft aufbewahrt wurden. Arb. Reichsgesundh. Amt., 26, 73-129.
113. Peabody, F.R., Mallmann, W.L., and Driesens, R.J. 1951 Studies on the cleaning and sanitizing value of high pressure steam for exposed surfaces. Quart. Bull., Michigan State College, 34, 22-29.
114. Pease, H.D., and Himebaugh, L.C. 1930 Hygiene of the towel. Am. J. Pub. Health and Nations Health, 20, 820-832.
115. Pfuhl, E. 1902 Vergleichende Untersuchungen über die Haltbarkeit der Ruhr bacillen und der Typhusbacillen auberhalt des menschlichen Körpers. Z. Hyg. Infektionskrankh., 40, 555-566.
116. Phelps, E.B., and Buchbinder, L. 1939 The survival rates and resultant pathogenic properties of B hemolytic streptococcus in an experimental room. Symposium on Airborne Infections. 3rd Internat. Congr. Microbiol. Rept. Proc.
117. Pulvertaft, R.J.V. 1929 Persistance of anaerobic bacteria in war wounds. Lancet, 2, 924-925.
118. Pulvertaft, R.J.V. 1947 Air-borne infection. Brit. Med. J., 2, 517-520.

119. Ransom, A., and Delepine, S. Proc. Roy. Soc., No. 336 (see Twichell, 1905).
120. Rebell, G., Pillsbury, D.M., Phalle, M. de Saint, and Ginsburg, D. Factors affecting the rapid disappearance of bacteria placed on the normal skin. J. Invest. Dermatol., 14, 247-264.
121. Robertson, O.H. 1944 A new approach to the control of airborne infection. Trans. Assoc. Am. Physicians, 58, 171.
122. Robertson, O.H. 1947 The dispersal of respiratory pathogens in relation to the occurrence and control of air-borne infections. Am. Rev. Tuberc., 55, 109-123.
123. Roelcke, K. 1938 Resistance of various dysentery bacilli. Z. Hyg. Infektionskrankh., 120, 307.
124. Ross, S.G. 1945 *Corynebacterium diphtheriae*: resistance to drying; acquired resistance and its stability. Med. J. Australia, 32, 42-44.
125. Rountree, P.M., and Armytage, J.E. 1946 Hospital blankets as source of infection. Med. J. Australia, 1, 503-506.
126. Rountree, P.M. 1947 Cross infection of wounds in a surgical ward during a trial of the use of oiled blankets. Med. J. Australia, 1, 427-430.
127. Rubbo, S., and Benjamin, M. 1951 Some observations on survival of pathogenic bacteria on cotton-wool swabs. Brit. Med. J., 1951, 983-987.
128. Sellers, A.F., and Gowen, G.H. 1944 Bacteriologic study of mess equipment. Bull. U.S. Army Med. Dept., 82, 111-116.
129. Semple, D. 1911 The relation of tetanus to the hypodermic or intramuscular injection of quinine. Scient. Mem., Officers of Med. and San. Dept., Gov't. of India., No. 43.
130. Sevitt, S. 1949 Source of two hospital-infected cases of tetanus. Lancet, 257, 1075-1078.
131. Shattock, S.G., and Dudgeon, L.S. 1912 Certain results of drying non-sporing bacteria in a charcoal liquid air vacuum. Proc. Roy. Soc. London, Series B., 85, 127-138.
132. Shaw, F.W., and von Gutfeld, F.J. 1944 Longevity of fungi on carriers. Virginia Med. Month., 71, 256-257.
133. Shechmeister, I.L., and Greenspan, F.S. 1947 The relation of the oil treatment of floors and bedding to the control of respiratory diseases among naval personnel. Am. J. Hyg., 46, 376-407.
134. Slavin, G. 1938 The resistance of the swine-fever virus to physical agencies and chemical disinfectants. J. Comp. Path. Therap., 51, 213-224.
135. Smeall, J.T. 1937 Bacterial content of public telephones. Lancet, 2, 776-777.
136. Stamp, Lord 1947 The preservation of bacteria by drying. J. Gen. Microbiol., 1, 251-265.
137. Sternberg, G. 1950 Two methods for the bacteriological testing of disinfectants. Acta Path. et Microbiol. Scand., 27, 134-141.
138. Stillman, E.G. 1940 The viability of pneumococci in dried rabbit blood. J. Infectious Diseases, 66, 171-173.
139. Sweany, H.C., and MacLane, C.C. 1919 Relation of dust to spread of tuberculosis. Illinois Med. J., 36, 302-305.

140. Symmers, D., and Cady, D.W. 1921 Occurrence of virulent anthrax bacilli in cheap shaving brushes. J. Am. Med. Assoc., 77, 2120-2121.
141. Tanaka, K. 1931 (Resistance of bacteria). Effect of metals and metal salts. J. Biochem., 13, 81-105.
142. Teague, O. 1913 Some experiments bearing upon droplet infection in diphtheria. J. Infectious Diseases, 12, 398-414.
143. Thurn, O. 1914 Ueber die Lebensfahigkeit an Olisekttragen ange trockneter ungefarbter und gefarbter Bakterian. Centr. Bakt., 74, 81-90.
144. Tinker, I.S., and Rudnew, G.P. 1930 Zum Studium über die Lebensfahigkeit des Bacillen pestis. Arch. Schiffs-Tropen-Hyg., 34, 554-559.
145. Tizzoni, G., and Cattani, G. 1891 Uber die Wider standsfährigkeit der Tetanusbazillen gegen physikalische und chemische Ein wirkungen. Arch. Exp. Path. Pharmakologie, 28, 41-60.
146. Tonney, F.O., and Noble, R.E. 1931 Relative persistence of Bacterium coli and aerogenes in nature; in decayed stumps. J. Bact., 22, 433-446.
147. Traum, J. 1934 Proc. Internat. Vet. Congress, 2, 87-101.
148. Trevelyan, E.F. 1898 The behaviour of the diphtheria bacillus outside the human body. J. San. Inst. 1897, London, 18, 430-434.
149. Uffelmann, J. 1894 Versuche über die Widerstandsfähigkeit der Typhusbacillen gegen Trocknung und über die Möglichkeit ihrer Verschleppung durch die Luft. Centr. Bakt., 1 Abt., Orig., 15, 133-140.
150. Vaillard, L., and Dopter, C. 1903 Ann. Inst. Pasteur, 17, 463.
151. Valleau, W.D., and Johnson, E.M. 1927 Commercial tobaccos and cured leaf as a source of mosaic disease in tobacco. Phytopath., 17, 513-522.
152. Van den Ende, M., Edward, D.G., and Lush, D. 1941 Reduction of dust-borne infection by treatment of bedclothes. Lancet, 716-718.
153. Van den Ende, M., Lush, D., and Edward, D.G.F. 1940 Reduction of dust-borne bacteria by treating floors. Lancet, 2, 133-134.
154. Van der Weyde, A.J. 1931 Disinfection of merchandise by high temperature in 1830. Nederl. Tijdschr. v. Geneesk., 79, 5902-5904.
155. Van Riemsdijk, M. 1924 Ueber die Lebensdauer der Diphtheriebacillen am Wattentupfer und eine einfache Methode, die Vitalität derselben zu erhöhen. Z. Hyg. Infektionskrankh., 103, 106-110.
156. Vincent, C. 1922 Isolation of anthrax bacillus from a shaving mug. J. Infectious Diseases, 31, 499-500.
157. Walliczek, H. 1894 Die Resistenz des Bacterium coli commune gegen Eintrocknung. Centr. Bakt., 15, 949-950.
158. Ward, W.E., and Dack, G.M. 1939 Bacteriologic tests on mechanical dishwashers for home use. Am. J. Pub. Health, 29, 1114-1118.

159. Weinzirl, J. 1907 The action of sunlight upon bacteria with special reference to B. _tuberculosis_. J. Infectious Diseases, Supp. 3, _4_, 128-153.
160. Weinzirl, J. 1914 The germicidal action of sunlight upon bacterial spores. Am. J. Pub. Health, _4_, 969-974.
161. Weiss, H. 1921 Viability of meningococcus. J. Med. Research, _42_, 321-324.
162. Winter, N.I. 1912 Z. Hyg., _70_, 291.
163. Wood, F.C. 1905 Viability of the pneumococcus after drying: a study of one of the factors in pneumonic infection. J. Exp. Med., _7_, 592-625.
164. Zinsser, H., and Hopkins, J.G. 1914 The viability of _Spirocheta pallida_ in diffuse light at room temperature. J. Am. Med. Assoc., _62_, 1802.

References (Surfaces) Addendum

1a. Bang, B. 1897 Die Aetiologie des Seuchenhaften (infectiosen) Verwerfens. Zeitschrift, fur Thier, 1, 241-278.

2a. Briscoe, C.F. 1912 Fate of tubercle bacilli outside the animal body. Illinois Agr. Exp. Sta. Bull., 161.

3a. Browne, A.W. 1949 The public health significance of *Salmonella* on poultry and poultry products. Ph. D. Thesis from Univ. of Calif.

4a. Cameron, H.S. 1932 The viability of *Brucella abortus*. Cornel. Vet., 22(3), 212-224.

5a. Dold, H. 1943 Ueber die Infektionsgefahr durch Wäsche die mir Krankheitskeimen(Typhus, Paratyphus, Enteritis und Ruhrbazillen). Verunreinigt ist. Arch. Hyg.u.Bakt., 131, 134-149.

6a. Dold, Hermann, and Ketteren, Maria 1947 Weitere verfleichende Untersuchungen über die Nachweisbarkeit von Bakterien der Ruhrgruppe und der T.P.E.-Gruppe in flüssigem und an Filtrierpapier angetrocknetem Stuhlmaterial. Ztschr. f. Hyg. u. Infektionskr., 127, 326-333.

7a. Downie, A.W., and Dumbell, K.R., 1947 Survival of variola virus in dried exudate and crusts from smallpox patients. Lancet, 1, 550-553.

8a. Foa, P., and Bordoni-Uffreduzzi, G. 1888 Veber die Aetiologie der Meningitis Cerebro-Spinalis epidemica. Ziet. f. Hyg., 4, 67-93.

9a. Firth, R.H.(Maj.), and Horrocks, W.H.(Maj.) 1902 An inquiry into the influence of soil, fabrics, and flies in the dissimination of enteric infection. Brit. M.J., 2, 936-943.

10a. Germano, E. 1897 Die Uebertragung von Infektionskrankheiten durch die Luft. II Mittheilung- Die Uebertragung der Diphtherie durch die Luft. Z. f. Hyg. v. Infektion., 25, 439-452.

11a. Harris, Franklin I., and Hoyt, Hubbard, S. 1919 Action of Ultra-Violet light on certain bacteria in relation to specific absorption of amino acids. Univ. Cali. Pub. Path., 2, 245-250.

12a. Hastings, E.G., 1923 Comparative resistance of bacteria from native habitats and from artificial cultures. Jour. Infect. Dis., 33, 526-530.

13a. Hare, E.D., O'Brien, J.R and Watkins, A.G. 1943 Dust as vehicle of infection in children's wards. Lancet, 2.

14a. Harrocks, W.H. 1906 Report of Commission on Mediterranean Fever. On the duration of life of *Brucella melitensis* in unsterilized soil. Harrison & Sons, London, IV, 27.

15a. Kennedy 1905 Rep. Comm. Medit. Fev. Part 3, 71.

16a. Klarmann, E.G., Wright, E.S., Shternov, V.A. 1951 In vitro studies relevant to control of secondary reservoirs of respiratory pathogens. Am. Jour. Pharm., 123(2), 42-59.

17a. Luyet, B.J., and Gehenio, P.M. 1938 The lower limit of vital temperatures-A Revier. Biodynamica, 33, 341.

18a. McCullock, E.C. 1945 Disinfection and Sterilization. Lea & Febeger, Philadelphia.

19a. Ostertag, R. 1908 Z. Infoktkr. Haustiere, 4, 1.

20a. Proctor, Bernard E., 1935 The microbiology of the upper air. J. Bact., 30(4), 363-375.
21a. Scavin, George 1938 The resistence of the swine-fever virus to physical agencies and chemical disinfectants. J. Comp. Path. Therap. 51, 213-214.
22a. Semple, D. 1911 The relation of tetanus to the hypodermic or intramuscular injection of Quinine. Sci. Mem., Officers of Med. & San. Dept. No. 43.
23a. Smith, C. Richard 1942 Survival of tubercle bacilli. The viability of dried tubercle bacilli in unfiltered room light, in the dark and in the refrigertor. Amer. Rev. Tuber., 45, 334-345.
24a. Smith, C.E. 1943 Coccidiodomycosis. Med. Clin. N. Amer., 27, 790.
25a. Soparkar, M.B. 1917 Vitality of tubercle bacillus outside the body. Indian Jour. Med. Res., 4, 627.
26a. Sormani, G 1886 Contribuzione agli studi sulla storia naturale del bacillo tuberculare. Estr. del Boll. Scient. No. 1.
27a. Soule, M.H. 1934 A microorganism carried by the dust storm. Science, 80, 14-15.
28a. Topley, W.W., and Wilson, G.S. 1946 Principles of Bacteriology and Immunity. 3rd Edition. The Williams & Wilkins Co., Baltimore, Md.
29a. Twichell D.C. 1905 The vitality of tubercle bacilli in sputum. Med. News N.Y., 87, 642-647.
30a. Twichell, D.C. 1906 Vitality of tubercle bacilli in sputum. Trans. Nat. Assn. for Study and Prev. of Tuberculosis., 1, 221.
31a. White, E. 1936 Lancet, 1, 941.
32a. Williams R.E.O. 1949 Examination of floor dust for haemolytic streptococci. Jour. Hyg., 47, 416-425.
33a. Valleay, W.D., and Johnson, E.M. 1927 Commercial tobaccos and cured leaf as a source of mosaic disease in tobacco. Phytopath, 17, 513-522.

List of references which are listed in the References (Surface) but no specific data has been used in the tables.

4a. Harris, Franklin I., and Hoyt, Hubbard, S. 1919 Action of Ultra-Violet light on certain bacteria in relation to specific absorption of amino acids. Univ. Calif. Pub. Path., 2, 245-250.

8. Anonymous 1921 Minist. Health Circ., No. 172.

21. Buchbinder, L., and Solotorovsky, M. 1941 Studies on micro-organisms in simulated room environments. VI. The disappearance of Vaccinia virus from the air. J. Bact., 42, 635-641.

59. Habs, H., and Ehrmeier, A. 1933 Clothing of unemployed and transmission of undulant fever. Deut. Med. Wochschr., 59, 1400-1402.

67. Ignatovich, Z.A., and Gokhberg, R.B. 1934 Determination of bacteria on external surface of bread. Sovet. Vrach. Gaz., 1812-1816.

92. Loosli, C.G., Wise, H., Lemon, H.M. Puck, T.T., and Robertson, O.H. 1946 The oil treatment of bedclothes for the control of dust-borne infection. Am.J. Hyg., 43, 105-119.

94. Luckiesh, M., Taylor, A.H., Knowles, T., and Leppelmeier, E.T. 1949 Inactivation of molds by germicidal ultra-violet energy. J.Franklin Inst., 248, 311-325.

154. Van der Weyde, A.J. 1931 Disinfection of merchandise by high temperature in 1830. Nederl. Tijdschr. v. Geneesk., 79, 5902-5904.

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
≠	present; plus
0	none
-	minus

THE PERSISTENCE (SURVIVAL) OF ORGANISMS IN WATER

TABLE ~~6~~1 THE SURVIVAL OF BACILLUS SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Bacillus anthracis			
Tap, 20C	6 d.	Bolton	1886
" 35C	55 hr.	"	"
Lake	12 yr.	Anon.	1921
Well	36 hr.	Emmerich	1889
Water, laboratory condition	18.5 yr.	Hastings	1923
Raw	5 mo.	"	"
Tap, 11-13C	3 d.	Hochstetter	1887
" 18-20C	Spores 154 d.	"	"
Water	72 hr.	Karlinski	1889
Tap, R.T., in spleen	3½ yr.	Konradi	1904
" " " culture	> 264 d.	"	"
" " " spores on silk thread	> 816 d.	"	"
Tap, body temp., in spleen	3 yr.	"	"
" " " " cult.	264 d.	"	"
" " " spores on silk thread	144 d.	"	"
Ster., R. T., in spleen	3½ yr.	"	"
" " " " cult.	> 264 d.	"	"
" " " spores on silk thread	> 816 d.	"	"
Ster., body temp., in spleen	1 yr.	"	"
Ster., body temp., in cult.	> 264 d.	"	"
Ster., " " spores on silk thread	144 d.	"	"
Well, tap, 10½C	Inoc. 1050-1180, 3 d.	Kraus	1887
Ster. muddy, stored in bottles in pond on plains	> 2 yr.	Minett	1950
Lake	12 yr.	Morris	1921
Stagnant pools	Viable	Naik	1938
River, 30-35, 7-10C	Recov. 34,800, 2 d.	Wolffhugel	1886
Filtered river, 35, 7-10C	Recov. 4 immediately	"	"
Bacillus yellow sp.			
Tap	208 d.	Hochstetter	1887
DISTILLED WATER			
Bacillus anthracis			
Dist. and filtered well, 20C-35C	90 d.	Bolton	1886
Ster. dist.	30 mo.	Hastings	1923
Dist.	Spores 154 d.	Hochstetter	1887
Dist., R.T., in cult.	> 264 d.	Konradi	1904
" " " spleen	3½ yr.	"	"
" body temp., in cult.	264 d.	"	"
Dist., " " " spleen	3½ yr.	"	"

TABLE W1 THE SURVIVAL OF BACILLUS SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Bacillus anthracis			
Tap, 20C	6 d.	Bolton	1886
" 35C	55 hr.	"	"
Lake	12 yr.	Anon.	1921
Well	36 hr.	Emmerich	1889
Water, laboratory condition	18.5 yr.	Hastings	1923
Raw	5 mo.	"	"
Tap, 11-13C	3 d.	Hochstetter	1887
" 18-20C	Spores 154 d.	"	"
Water	72 hr.	Karlinski	1889
Tap, R.T., in spleen	3½ yr.	Konradi	1904
" " " culture	> 264 d.	"	"
" " " spores on silk thread	> 816 d.	"	"
Tap, body temp., in spleen	3 yr.	"	"
" " " " cult.	264 d.	"	"
" " " spores on silk thread	144 d.	"	"
Ster., R. T., in spleen	3½ yr.	"	"
" " " " cult.	> 264 d.	"	"
" " " spores on silk thread	> 816 d.	"	"
Ster., body temp, in spleen	1 yr.	"	"
Ster., body temp., in cult.	> 264 d.	"	"
Ster., " " spores on silk thread	144 d.	"	"
Well, tap, 10½C	Inoc. 1050-1180, 3 d.	Kraus	1887
Ster. muddy, stored in bottles in pond on plains	> 2 yr.	Minett	1950
Lake	12 yr.	Morris	1921
Stagnant pools	Viable	Naik	1938
River, 30-35, 7-10C	Recov. 34,800, 2 d.	Wolffhugel	1886
Filtered river, 35, 7-10C	Recov. 4 immediately	"	"
Bacillus yellow sp.			
Tap	208 d.	Hochstetter	1887
DISTILLED WATER			
Bacillus anthracis			
Dist. and filtered well, 20C- 35C	90 d.	Bolton	1886
Ster. dist.	30 mo.	Hastings	1923
Dist.	Spores 154 d.	Hochstetter	1887
Dist., R.T., in cult.	> 264 d.	Konradi	1904
" " " spleen	3½ yr.	"	"
" body temp., in cult.	264 d.	"	"
Dist., " " " spleen	3½ yr.	"	"

TABLE <u>U/</u> (CONT'D) THE SURVIVAL OF BACILLUS SPECIES IN WATER

Factor(s)	Survival	Reference	
DISTILLED WATER			
<u>Bacillus anthracis</u>			
Dist., R.T., spores on silk thread	>816 d.	Konradi	1904
Dist., body temp., spores on silk thread	>144 d.	"	"
Dist., 25C, direct sun, strong wind	Inoc. 8000 coln., 2 hr.	Kruse	1897
Dist.	Up to 80 d.	Panisset	1925
"	20 mo.	Sirena	1894
Ster. dist., 15-20C	131 d.	Strauss	1889
Dist.	90 d.	T. & W.	1946
<u>Bacillus cereus</u>			
Dist., pH 6	Inoc. 100%, 2% in 120min	Winslow	1927
" " 7	" " 40% " " "	"	"
" " 8	" " 23% " " "	"	"
" " 9	" " 49% " " "	"	"
" centrifuging, pH 6	" 12,000,000/cc; Recov. 9,000/cc; 60 "	"	"
" " " 7	Inoc. 17.,000,000/cc; Recov. 3,000/cc; 60 "	"	"
" " " 8	Inoc. 242,000,000/cc; Recov. 12800/cc; 60 "	"	"
" " " 9	Inoc. 271,000,000/cc; Recov. 10200/cc; 60 "	"	"
<u>Bacillus megatherium</u>			
Dist., pH 6	Inoc. 100%; 61% in 90min	"	"
" " 7	" " 132% " " "	"	"
" " 8	" " 71% " " "	"	"
" " 9	" " 82% " " "	"	"
<u>Bacillus spp.</u>			
Dist., 10-17C	12d.	Hochstetter	1887
Dist.	Relatively short	Zobell	1932
Redist., R.T.	4-5 wk.	"	"
ICE			
<u>Bacillus mesentericus</u>			
Ice	Present	Haines	1937
SALINE SOLUTIONS			
SEA			
<u>Bacillus anthracis</u>			
Sea, bouillon	Inoc. exclusively, 5 d.	De Giaxa	1889
" agar	" very few, 1 d.	" "	"
"	20 mo.	Sirena	1894
Ster. sea, bouillon	Inoc. 1052, 36 d.	De Giaxa	1889
SEWAGE			
<u>Bacillus anthracis</u>			
Sewage, R.T.	Inoc. 10,000/cc; 19 d.	Gillissen	1950
Mud of sewage, R.T.	" " " 5 wk.	"	"
Sedimentation pond	" " " >10 d.	"	"
Sewage	16 mo.	Sirena	1894
OTHERS			
<u>Bacillus anthracis</u>			
Seltzer, 11-13C and 18-20C	1 hr. and spores 154 d.	Hochstetter	1887

TABLE 42 THE SURVIVAL OF BRUCELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
<u>Brucella melitensis</u>			
Water favorable condition	10 wk.	Bang	1897
Ster. tap	20 d.	Kenndy	1905
<u>Brucella abortus</u>			
Pasture water	> 8 d. < 30 d.	Christiansen	1950
<u>Brucella suis</u>			
Tap	77 d.	Bryan	1934
SALINE SOLUTIONS			
PHYSIOLOGICAL			
<u>Brucella spp.</u>			
Salt soln.	in 0.25% than 0.85% Above pH 8 and below pH 6.6 shorter viability	Zobell	1932

TABLE W 3 THE SURVIVAL OF BACTERIOPHAGE IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
E. coli phage			
Tap, pH 7.5, 45-75C	Death rate of first order	Chang	1950
Water, pH 5.2, alkaline	Present	Marginesu	1929
S. typhosa phage			
Water, pH 5.2, alkaline	Not present	"	"
Rivers of cities	More in summer mo.	DeAssumpeao	1943
S. paratyphi phage			
Rivers of cities	" " " "	"	"
Sh. dysenteriae phage			
Water, pH 5.2, alkaline	Not present	Marginesu	1929
Micrococcus phage			
Water, pH 5.2, alkaline	Present	"	"
Vibrios phage			
Water	Disappearance of Vibrios	D'Herelle	1926
DISTILLED WATER			
Virus T_2 phage			
Dist., daylight	3% after 72 hr. of ir-ration	Latarjet	1951
" white hot bulb	0% after 65 hr. " " ration	"	"
SALINE SOLUTIONS.			
SEA			
S. typhosa phage			
Sea	Recov. 10% in 7 d.	Guelin	1948
S. paradysenteriae phage			
Sea	Recov. 9% in 30 d.	"	"
E. coli phage			
Sea	" " " " "	"	"
General phage			
Sea	Longer than bacteria	"	"
SALINE SOLUTIONS			
PHYSIOLOGICAL			
S. typhosa phage			
Saline	4% in 3 d.	Guelin	1948
Sh. paradysenteriae phage			
Saline	2% in 2 d.	"	"
E. coli phage			
Saline	1% in 2 d.	"	"
SEWAGE			
General phage			
Sewage	Varies seasonally	Beckwith	1930

TABLE W4 THE SURVIVAL OF CLOSTRIDIUM SPECIES IN WATER

Factor(s)	Survival	Reference	
ICE			
Clostridium botulinum			
Ice, -16C	14 mo.	Tanner	1931
SEWAGE			
Clostridium perfringens and sporogenes			
Activated sludge	After being pressed and heated was present	Greer	1926

TABLE 142 THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Escherichia coli			
Polluted, 20C	Recov. 827; 72 hr.	Albert	1917
" 37C	" 384; " "	"	"
Well, outside temp.	Inoc. 1-301 of infected water, 55 d.	Bartos	1947
" " " , with S. typhimurium	6 d.	"	"
Well, outside temp., " S. typhosa	30 d.	"	"
Well, outside temp., " Sh. spp.	30 d.	"	"
Well, R.T., pH 7.8-8.2	Inoc. 6.3-9.8 million 55 d.	"	"
Water, full radition iron ore, under glass cooled	5-30 min.	Bazzoni	1914
Tap 22C	>200 d.	Bigger	1934
River, 35-4C	>6 d. and 3 d. resp.	Bogolyubov	1946
Water plus sunlight	Inoc. 100,000, 1 hr.	Buchner	1892
River coliform in tap	>70 d.	Burke	1931
River	Not given	Butterfield	1928
Water plus ultraviolet rays	Few sec.	Bujwid	-
Water plus chloramine	Am't of chloramine and length of exposure effect survival	Butterfield	1946
Spring	Longer than has been reported	Catalano	1947
Water	At constant pH and rise in temp. E. coli dies faster than S. typhosa	Cohen	1922
Water, 25 Kg, press. of carbon dioxide	>5 d.	Colin	1915
Water, R. T., 6-10C	Eratic fluctions in cts.	Cox	1949
River, weaklight	Inoc. 72,000,000; 46 d.	Arloing	1931
" daylight	" " " "	"	"
" natural	" " 87 d.	"	"
" filtered	" " " "	"	"
" " and heated to 120C	" " " "	"	"
Iced and not iced water for shipment	Little importance	Ellison	1928
River	Isolated every test period	Ford	1912
Well	Grows in pump grease for contamination	Frantsev	1935
Unster., cold 8C	Prolongs, 84 d.	Hale	1910
" hot 37C	Curtails, 8-10 d.	"	"
Water	Death increases with temp.	Hinds	1932
Surface	Rarly occur on long storage	Holwerda	1928

TABLE 107 (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference
NATURAL WATERS (cont'd)		
Escherichia coli		
Well, R. T.	31 d.	Horrocks 1903
River, R.T.	2 mo.	" "
Ster. river	2-3 mo.	" "
River, winter	After 10 hr. 80%	Hoskins 1935
" summer	" " " 67.3%	" "
River, cold	Prolongs	Houston 1911
" hot	Curtails	" "
Tap, 20C	Dies rapidly	" 1912
Ship tanks, 27C, purified 10x	Inoc. 100cc, 25 d.	Jones 1936
Tank not cleaned for 7 mo. 19C	" 4cc, 54 d.	" "
Tank uncleaned for 15 mo.	" 1000cc, 15 d.	" "
Steam ster. lake, R.T., dark	Inoc. 1925, 262 d.	Jordan 1895
Water	Not given	Kister 1930
Tap	61 d.	Kusama 1925
Natural plus chlorine	Pathogenes found on occasion	Levine 1947
Ster., 10-15C, diffuse sun	13 d.	McNaught 1910
" 12-15C, inside window	>15 d.	" "
Ag treated water	0 at 30 min.	Mallmann 1937
Water, 12C	Recov. 1236, 1 d.	Maccolin 1946
" "	" 756, 6 d.	" "
" 17C	" 989, 14 d.	" "
" "	" 1248, 14 d.	" "
Well, R.T., 0.35-0.65% Cl, traces of nitrate and nitrite	2-5 mo.	Mazzeo 1940
Water	2-3 wk.	Ministry of Health 1934
"	Low conc. of Cl stimulate growth	Nordgren 1939
Commercial spring, 20C	Inoc. 99,750,000; Recov. <10; 45 d.	Obst 1919
Ster. river, 18C, dark	Inoc. 27,000/cc; Recov. 4,900/cc; 73 d.	Platt 1935
" " " diffuse	Inoc. 27,000/cc; Recov. 0; 52 d.	" "
" " 37C, dark	Inoc. 27,000/cc; Recov. 0; 30 d.	" "
" " 0-2C	Inoc. 27,000/cc; Recov. 3,900/cc; 73 d.	" "
" " dark, 18C, with E. coli and A. aerogenes	Inoc. 57,000/cc; Recov. 9,700/cc; 73 d.	" "
Ster. river, diffuse, 18C, with E. coli and A. aerogenes	Inoc. 57,000/cc; Recov. 420,000/cc; 73 d.	" "

TABLE 1W7 (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
Escherichia coli			
Ster. river, dark, 37C, with E. coli and A. aerogenes	Inoc. 57,000/cc; Recov. 0; 30 d.	Platt	1935
Raw river, 0-2C	Inoc. normal river flora Recov. 0; >29 d.	"	"
" " dark, 18C	Inoc. normal river flora Recov. 0; >1 <5 d.	"	"
" " diffuse light, 18C	Inoc. normal river flora Recov. 0; > 1 <5 d.	"	"
Raw river, incubator, 37C	Inoc. normal river flora Recov. 0; > 1 <5 d.	"	"
" " dark, 18C	Inod. >10,000; Recov. 0, >1 <5 d.	"	"
" " 0-2C	Inoc. >10,000; Recov. 0, >5 <9	"	"
" " diffuse, 18C	Inoc. >10,000; Recov. 0, >5 <9	"	"
" " incubator, 37C	Inoc. >10,000; Recov. 0, >5 <9	"	"
Stored river in open masonry tank durring monsoon and hot weather	>4 mo.	Raghavachavi	1939
Tap, litmus lactose	48 d.	Rector	1917
" dextrose liver	64 d.	"	"
Bottle of water, litmus lactose	25 d.	"	"
Bottle of water, dextrose liver	36 d.	"	"
River, 26C, tank not cleaned for 7 mo.	Recov. present in 1000cc, 54 d.	Royds	1936
River, 28C, tank not cleaned for 15 mo.	Recov. " " 300cc, 14 d.	"	"
River, 28C, tank cement washed	Recov. present in 12.5cc, 0 d.	"	"
River, 2?C Tank empied without cleaning	Recov. present in 100cc, 7 d.	"	"
Streams, cold	Prolongs	Ruediger	1911
" hot	Curtails	"	"
Raw, ultraviolet	Inoc. 1500, 15 sec.	Schwarz	1911
Stagnant	Dies rapidly in summer	Stundl	1941
Water, 13-17C	Increase	Taylor	1947
Water, dark, stored	>20 yr.	Teissier	1919
Deep well, 22C, on agar	Inoc. 84/cc, Recov. 3500, 24 hr.	Thresh	1910
" " 0C " "	Inoc. 84/cc, Recov. 18/cc 24 hr.	"	"
" " 22C, on gel.	Inoc. 23/cc, Recov. 1.700 /cc, 24 hr.	"	"
" " 0C, " "	Inoc. 127/cc, Recov. 86/cc, 24 hr.	"	"

TABLE 1̸1/2 (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
Escherichia coli			
Water, after centerifuging	280 d.	Winslow	1927
1 hr. later	131 d.	"	"
Water, 37C, pH 4	Recov. 1%, 9 hr.	"	1923
" " " 5	" 82%, 9 hr.	"	"
" " " 6	" 106%, 9 hr.	"	"
" " " 7	" 54%, 9 hr.	"	"
" " " 7.5	" 35%, " "	"	"
" " " 8	" 12%, " "	"	"
Boiled or steamed hard water, capsulated non-excretal	2-3½ yr.	Wood	1943
Boiled or steamed hard water, noncapsulated excretal	5 wk.	"	"
River	45 d.	Webster	1934
"	34 d.	"	"
DISTILLED WATER			
Escherichia coli			
Distilled	31¼ mo.	Ballantyne	1930
" , 0-8C	16 mo.	"	"
" full radition with Hg, under glass cooled	30-5 min.	Bazzoni	1914
Distilled water with talc. 37C	220 d.	Bigger	1941
Distilled water with talc. 22C	335 d.	"	"
Distilled water with K_2MnO_4 and KOH	72 hr.	Burke	1936
Double dist.	Longer than has been reported	Catalano	1947
Dist.	51 d.	Cramarossa	1927
" , gelose	2 d.	Duhot	1933
" bouillon	75 d.	"	"
"	4-7 d., K value 0.175 33.0% reduct/d.	Heller	1941
"	69 d.	Kusama	1925
"	Died more rapidly with increase in temp.	Levine	1921
" , 37C	Up to 74 d.	Panisset	1925
" litmus lactose	48 d.	Rector	1917
" dextrose liver	57 d.	"	"
" pH 2	Recov. 1%, 4 hr.	Shaughnessy	1925
" " 6	" 115%, 4 hr.	"	"
" " 8	" 120%, " "	"	"
" " 11	" 4%, 4 hr.	"	"
" " 6-6.9	Most favorable zone	"	1924
Ster. Dist., 37C, agar 3 d.	50 d.	Slater	1893
Dist.	Greater than in sucrose	Tanner	1944

TABLE (11) (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
DISTILLED WATER (cont'd)			
Escherichia coli			
Dist., 60-142C,	Inoc. 16-20 hr. cult. in 6 cc water, 1 hr.	Tinti	1923
"	74 d.	Webster	1934
" pH 6	Inoc. 84% at 1 hr., Recov. 77 at 24 hr.	Winslow	1923
"	93.7% recov., 24 hr.	Zobell	1937
ICE			
Escherichia coli			
Ice, clear and core	Fewer alive in clear	Christomanos	1898
Ice	3-5 d.	Fraenkel	-
Ice, - 20C	Inoc. 0.1cc suspn., 163d.	Haines	1937
" -2C	" " " 11 d.	"	"
" -6C	93-99% death	Hilliard	1918
Glucose in tap, -10C	50% death, 3 hr.	"	"
Tap, -20C	3 wk.	Keith	1913
Water, -20C	Many mo., metabilism and the protection offered by the medium effect	"	"
Dist, -21 to -78C	Inoc. 10,000-100000/ml., more resistant to freezing than thawing	Lund	-
Water, -8 to -30C	30 d.	Lu-Ti-Huan	1930
Dist., -10C, pH 6.5	Inoc. 15.20m/cc, 68.5% killed 1 wk.	McFarlane	1941
" -20C, pH 6.5	Inoc. 15.20m/cc, 34% killed 1 wk.	"	"
" -10C, pH 5	Inoc. 2,310,000; 99.9% killed 32 wk.	"	"
" -20C, " "	Inoc. 2,310,000; " killed 32 wk.	"	"
" -10C, " 3.6	Inoc. 1.5-2.5m/cc; " killed 1 wk.	"	"
" -20C, " "	Inoc. 1.5-2.5m/cc; " killed 1 wk.	"	"
" -16, -40, and -79C	Long time	Tanner	1931
SALINE SOLUTION			
SEA			
Escherichia coli			
River and sea	Bacteriophage effect survival	Arloing	1925
Sea, filtered	Inoc. 500,000/cc; >35 d.	Beard	1935
" unfiltered	" 1,200/cc; >35 d.	"	"
" infected by ducks	Present	Bidwell	1950
"	2 d.	Gohar	1948
" Seitz filtered	4 d.	"	"
" " " , autoclaved	39 d.	"	"
Sea, " , Seitz filtered, pulp disc	10 d.	"	"
Sea, Seitz filt, 60C	5 d.	"	"
" " " 100C	27d.	"	"

TABLE W1 (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
SALINE SOLUTION			
SEA			
Escherichia coli			
Sea, autoclaved	5 d.	Guelin	1948
" not autoclaved	5 d.	"	"
" 20C	Dies rapidly	Houston	1912
Ster. sea, 22C	Inoc. gelatine lactose, Recov. < 100, 80 d.	Violle	1942
Sea	Could not be isolated	Zobell	1941
Salt lake	Sewage bact. Recov. 4.8% 24 hr.	"	1937
PHYSIOLOGICAL			
Escherichia coli			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
" " R.T.	31¼ mo.	"	"
Physiological soln., full radition, under glass and cooled	5 min.	Bazzoni	1914
Saline	32 d.	Cramarossa	1927
" , cultured in gelose	7 d.	Duhot	1933
Saline, bouillon	>90 d.	"	"
"	K value 0.085, 17.7% reduction 1 d.	Heller	1941
NaCl, 1.45M soln., pH 2	Recov. 2%, 4 hr.	Shaughnessy	1925
" " " " 6	" 65%, 4 hr.	"	"
" " " " 8	" 0%, 4 hr.	"	"
" " " " 11	" " "	"	"
" 0.145M " " 2	" " " "	"	"
" " " " 6	" 88%, 4 hr.	"	"
" " " " 8	" 112%, 4 hr.	"	"
" " " " 11	" 0%, 4 hr.	"	"
" 0.0145M " " 2	" .1%, 4 hr.	"	"
" " " " 6	" 91%, " "	"	"
" " " " 8	" 60%, " "	"	"
" " " " 11	" 0%, 4 hr.	"	"
SEWAGE			
Escherichia coli			
Sewage	Cts. higher in summer than in winter	Allen	1949
" plus cloroben	50-90% killed	Brown	1947
" in streams	Found 12 mi. below outlet, on sunny days 2.9 mi.	"	1916
Sewage	Milt. on storage at high temp.	Butterfield	1933
" , aerated 62 hr.	Inoc. 1:300, 6 hr.	Carlson	1943
" and irrigation water	Not given	Chapman	1935
Sewage	Not sufficient to cause disease	Crawford	1940
Sewage ordinary	53-65 d.	Firth	1902

TABLE [illegible] (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference
SEWAGE		
Escherichia coli		
Crude sewage	12 d.	Firth 1902
Sewage with phosphate buffer	>4 d.	Heukelekian 1933
River plus 45% sewage	After 46 hr. 60%	Hoskins 1935
Sewage held in parchment bag in running water	Inoc. 190 T, Recov. 30/cc 7 d.	Rogers 1918
Ster. water and feces, 20C	Inoc. 4,700,000/cc at 31 d., Recov. 38,750/cc 278 d.	" "
Feces and natural water	2 d.	Savage 1917
Sewage, winter	>26 d.	Shimomura 1935
" summer	>7 d.	" "
NATURAL WATERS		
Escherichia intermedium		
River	45 d.	Webster 1934
"	34 d.	" "
Water, 37C, pH 4	Recov. 1%, 9 hr.	Winslow 1923
" " " 5	" 82%, 9 hr.	" "
" " " 6	" 106%, 9 hr.	" "
" " " 7	" 54%, " "	" "
" " " 7.5	" 35%, " "	" "
" " " 8.0	" 12%, " "	" "
Aerobacter aerogenes		
Well	>1 yr.	Caldwell 1933
River, Ster., ice chest 0-2C	Inoc. 30,000/cc; Recov. 0, 21 d.	Platt 1935
River, ster., dark, 18C	Inoc. 30,000/cc; " 4,900.cc; 73 d.	" "
River, ster., diffuse light, 18C	Inoc. 30,000/cc; " 420,000/cc; 73 d.	" "
River, ster., incubator, 37C	Inoc. 30,000/cc; " 0, 1 d.	" "
Raw river, ice chest, 0-2C	Inoc. normal river, Recov. 0, >29 d.	" "
Raw river, dark, 18C	Inoc. normal river, Recov. 0, >9 <14 d.	" "
Raw river, diffuse light, 18C	Inoc. normal river, Recov. 0, >1 <5 d.	" "
Raw river, incubator, 37C	Inoc. normal river, Recov. 0, >5 <9 d.	" "
Ster. river, ice chest, 0-2C, plus E. coli	Inoc. 57,000/cc; Recov. 5,900/cc, 73 d.	" "
Ster. river, dark, 18C, plus E. coli	Inoc. 57,000/cc; Recov. 9,700/cc; 73 d.	" "
Ster. river, diffuse light 18C, plus E. coli	Inoc. 57,000/cc; Recov. 420,000/cc; 73 d.	" "
Ster. river, incubator, 37C, plus E. coli	Inoc. 57,000/cc; Recov. 0, 30 d.	" "
Water before contamination 37-22C	Recov. 23-30, 1 d. and 35-51, 56 d.	Gray 1932

TABLE 65 (CONT'D) THE SURVIVAL OF COLIFORM BACTERIA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
Aerobacter aerogenes			
Water, 10C	Prevalent	Taylor	1947
Tap, diffuse light	Inoc. 46%, Recov. 71%, 60 d.	Winslow	1918
Water plus E. coli	98-99% reduction 10 d. A. aerogenes decreased more rapidly	"	"
Tap plus E. coli, diffuse light, and dark, R.T.	E. coli died more rapid	"	"
Aerobacter cloacae			
River	Constant	Ford	1912
Aerobacter spp.			
Water, 12C	Recov. 1804, 1 d.	Maccolini	1946
" "	" 7800, 6 d.	"	"
" 17C	" Innumerable	"	"
" "	" "	"	"
DISTILLED WATER			
Escherichia intermedium			
Dist.	59 d.	Webster	1934
"	62 d.	"	"
SEWAGE			
Aerobacter aerogenes			
Crude sewage and effluent	About the same as E. coli	Atkinson	1934
Ster. water plus feces, 20C	Inoc. 4,700,000 at 31 d. Recov. 38,750/cc; 278d	Rogers	1918

TABLE *a6* THE SURVIVAL OF LEPTOSPIRA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATER			
L. icterohaemorrhagiae			
Pit water	Months	Buchannan	1927
Water, 5-32C	3-9 d.	Chang	1948
Ster. tap, pH 7.0-7.1, 26C	30-32 d.	"	"
" " " " " 5-6C	16-18 d.	"	"
Tap with bact., neutral pH	4 wk.	"	"
River, pH 7.1-7.0	5-6 d.	"	"
Tap with 1% serum, 25-27C, pH 7.2-7.3	>3 mo.	"	"
River	48 hr.	Noguchi	1918
Stagnant, 25-32C, pH 7.6	Inoc. 1cc. active cult., 55 d.	Sawyer	1928
" " " " "	Inoc. 1cc. active cult., 55 d.	"	"
" " " " "	Inoc. 1 cc. " " 115 d.	"	"
DISTILLED WATER			
L. icterohaemorrhagiae			
Dist.	7 d.	Noguchi	1918
SALINE SOLUTION			
SEA			
L. icterohaemorrhagiae			
Sea	18-20 hr.	Chang	1948
SEWAGE			
L. icterohaemorrhagiae			
Sewage	7-8 d.	Chang	1948
Polluted water	More in summer and fall	Gardner	1946
Feces and tap, 25-32C	Inoc. 0.5cc. active cult., 55 d.	Sawyer	1928

TABLE 67 THE SURVIVAL OF METAZOA AND PROTOZOA IN WATER

Factor(s)	Survival	Reference
NATURAL WATERS		
Endamoeba histolytica		
Water, R.T. for 4 hr.	2 d.	Beaver 1949
" 14C, for 4 hr.	" "	" "
" R.T. for 1 hr.	4 d.	" "
" 14C for 12 hr.	" "	" "
" 28-340C	" "	" "
Chlorinated water	Not all of cysts die	Becker 1946
Water, R.T.	10 min.	Bolduc 1935
" ultraviolet rays	Short time	Chamberlain -
" 45C	Inoc. 1,100; 105 min.	Chang 1950
" 47C	" " 32 "	" "
" 49C	" " 8 "	" "
" 50C	" " 2 "	" "
" R.T.	5 wk.	Dobell 1919
Drinking water	Can be transmitted	Hegner 1934
Water, pH 6.5-6.7, 45-54.5C	> 2 hr. 1 min.	Jones 1948
Water, 7cm. deep, sun 36C	50% left in 2 hr.	Kuenen 1913
"	Inoc. 50 cysts; Recov. 47; 9 d.	" "
Slow running water	15 d.	Penfold 1916
Trichomonas vaginalis		
Water	35-45 min.	Jerovic 1948
Ancylostoma duodenale		
Water, 60F	18 mo.	Nicoll 1917
Ancylostoma sp.		
Water, by lab window	12 mo.	Loebker 1906
Necator americanus		
Water, 60F	18 mo.	Nicoll 1917
DISTILLED WATER		
Endamoeba histolytica		
Dist., 12-22C	153 d.	Boeck 1921
" tap, R.T.	14 d.	Dobell 1926
Endamoeba coli		
Dist., 12-22C	244 d.	Boeck 1921
Giardia intestinalis		
Dist., 12-22C	32-66 d.	" "
Chilomastix mesnili		
Dist., 12-22C	187 d.	" "
SEWAGE		
Endamoeba histolytica		
Sludge, 103C	Inoc. 500,000; 48 hr.	Cram 1943
Dilute feces	>1 mo.	Wenyon 1917
Ascaris lumbricoides		
Sludge, 103C	Egg lives 3 min.	Cram 1943
" "	" " 151 d.	" "
"	62 d.	Wright 1942
Acylostoma sp.		
Sludge, 103C	5 d.	Cram 1943
Taenia saginata		
Sludge, digestion, 75-85F	Inoc. 600,000; 6 mo.	Newton 1949
Trichuris trichiura		
Sludge	22 d.	Wright 1942

TABLE W1 (CONT'D) THE SURVIVAL OF METAZOA AND PROTOZOA IN WATER

Factor(s)	Survival	Reference
NATURAL WATERS		
Paramecium		
Sewage	Die in few days.	Purdy 1918
General		
Sewage	Protozoa and bacteria rapid increase in protozoa, decrease in bacteria	" "

TABLE W8 THE SURVIVAL OF MICROCOCCUS [redacted] WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Micrococcus aurantiacus			
Tap, 10-17C	22 d.	Hochstetter	1887
Micrococcus spp.			
Tap, 20C	2-4 d.	Bolton	1886
Impure filtered, 20C	4-6 d.	"	"
Tap, 35C	2-4 d.	"	"
Impure filtered, 35C	2-4 d.	"	"
Unfiltered well, 20C	4-6 d.	"	"
" " 35C	4-6 d.	"	"
Tap, R.T., in cult.	508 d.	Konradi	1904
" " in pus	545 d.	"	"
" body temp., in cult.	438 d.	"	"
" " " " pus	511 d.	"	"
Ster., R.T., in cult.	30 d.	"	"
" " " pus	" "	"	"
" body temp., in cult	30 d.	"	"
" " " " pus	" "	"	"
Swimming pool plus Cl	30 min.	Ritter	1948
Ster. tap without Cl	7 hr.	"	"
Ster. soda water, 37 C	Inoc. agar cult. 48 hr. old; 12 d.	Slater	1893
Water	10-20 d.	Veissfeiler	1935
DISTILLED WATER			
Micrococcus pyogenes var. aureus (Staph. aureus)			
Dist.	32 d.	Cramarossa	1922
Micrococcus pyogenes var. albus			
Dist.	48 d.	"	"
Micrococcus spp.			
Distilled tap and well, 20C	20-30 d.	Bolton	1886
Distilled " " " 35C	5-10 d.	"	"
Distilled, 20C	2-4 d.	"	"
" 35C	2-4 d.	"	"
Dist. R.T., in cult.	30 d.	Konradi	1904
" " " pus	" "	"	"
" body temp., in cult.	438 d.	"	"
" " " " pus	469 d.	"	"
Ster. dist., 15-20C	21 d.	Strauss	1889
Dist, 60-142C	Inoc. 16-20 hr. cult. in 6 cc. water; 1 hr.	Tinti	1923
Micrococcus aurantiacus			
Dist., 10-17C	22 d.	Hochstetter	1887
ICE			
Micrococcus pyogenes var. aureus (Staph. aureus)			
Water, alternate freezing and thawing	Inoc. 111,782/cc; 96 hr.	Prudden	1887
Contaminated, 14-30F	Recov. 49,280/cc; 66 d.	"	"
Dist., -20 to -78C	Inoc. 10,000-100,000/ml. More resistant to freezing	Lund	-

TABLE W8 THE SURVIVAL OF MICROCOCCUS SPECIES IN WATER

Factor(s)	Survival	Reference
SALINE SOLUTIONS		
SEA		
Micrococcus pyogenes var. aureus (Staph. aureus)		
Sea, bouillon	Inoc. 3/4, 36 d.	De Giaxa 1889
" agar	" almost exclusively 9 d.	" " "
Ster. sea, bouillon	Inoc. rich growth, 36 d.	" " "
PHYSIOLOGICAL		
Micrococcus pyogenes var. aureus (Staph. aureus)		
Saline	29 d.	Cramarossa 1927
Micrococcus pyogenes var. albus		
Saline	23 d.	" "
OTHERS		
Micrococcus aurantiacus		
Seltzer, 10-17C	16 d.	Hochstetter 1887

TABLE W9 THE SURVIVAL OF MICROORGANISMS IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Alcaligenes faecalis			
River	Constant	Ford	1912
Corynebacterium diphtheriae			
Ster. R.T.	3 d.	Lomry	1929
" 37C	30 hr.	"	"
Neisseria gonorrhoeae			
Ster. tap, 37C	22 min.	Bengtson	1925
Bacterium phosphorescens			
Fresh	1 wk.	Korinek	1926
DISTILLED WATER			
Alcaligenes faecalis			
Dist.	18 d.	Cramarossa	1927
Neisseria gonorrhea			
Ster. dist., 37C	22 min.	Bengtson	1925
Dist., 18-22C	Inoc. 24 hr. cult., Recov. 60.4%, 6 hr.	Pieper	1930
" " "	Inoc. 48 hr. cult., Recov. 70%, 6 hr.	"	"
ICE			
Lactobacillus casei			
Dist., -21 to -78C	10,000-100,000/ml, more resistant to freezing than thawing	Lund	-
Neisseria gonorrhea			
Ice	9-15 d.	Hampil	1932
SALINE SOLUTIONS			
PHYSIOLOGICAL			
Alcaligenes faecalis			
Saline	21 d.	Cramarossa	1927
Neisseria gonorrhea			
Physiological NaCl, R.T.	Inoc. 24 hr. agar cult. Recov. 79.2%, 6 hr.	Pieper	1930
" " "	Inoc. 48 hr. agar cult. Recov. 57.9%, 6 hr.	"	"
SEWAGE			
Bacterium salmonicida			
Domestic sewage	15 d.	Duff	1940
Sewage after removal of original sewage	13-67 d.	"	"
NATURAL WATERS			
Erysipelothrix spp.			
Drinking water	4-5 d.	Hettche	1937
SALINE SOLUTIONS			
SEA			
Erysipelothrix sp.			
Sea ster.	1 wk.	Hettche	1937

TABLE W10 THE SURVIVAL OF MICROORGANISMS IN WATER
(Klebsiella, Serratia, Proteus, & Pseudomona)

Factor(s)	Survival	Reference	
NATURAL WATERS			
Serratia marcescens			
Impure well, 20C	310 d.	Bolton	1886
Water, spring	Present	Mazurczak	1945
Tap, 10-17C	109-98 d.	Hochstetter	1887
Raw with ultraviolet	Inoc. 250,000/cc; 15 sec.	Schwarz	1911
Water plus potato juice with peptone, diffuse light	48 hr.	Symon	1947
Proteus sp.			
River	Found	Ford	1912
Pseudomonas pyocyanea			
Water, Hg and Fe ore radition, under glass, cooled	1 min. at 8 cm.	Bazzoni	1914
All kinds of water	Flourished	Frankland	1886
Pseudomonas spp.			
Tap, 12-17C	14 d.	Hochstetter	1887
Aerated, 22C	Inoc. 4 d. old gel. cult, 16 d.	Slater	1893
DISTILLED WATER			
Klebsiella pneumoniae			
Distilled	31½ mo.	Ballantyne	1930
"	Up to 76 d.	Panisset	1925
Ster. dist., 15-20C	8 d.	Strauss	1889
Serratia marcescens			
Dist., 20C	48 d.	Bolton	1886
" 35C	14 d.	"	"
" 10-17C	7 d. - 5 d.	"	"
"	36 d.	Cramarossa	1922
Pseudomonas pyocyanea			
Dist., 37C	30 3/4 mo.	Ballantyne	1930
"	31½ mo.	"	"
" 0-8C	25 mo.	"	"
"	85 d.	Cramarossa	1922
Pseudomonas spp.			
Dist.,12-17C	14 d.	Hochstetter	1887
" plus Cu 1/10m.	2 hr.	T. & W.	1932
ICE			
Serratia marcescens			
Water, -10 to -1C	Continous freezing 51 d.	Hilliard	1918
Contaminated, 14-30F	Recov. 6,300/cc, 51 d.	Prudden	1887
Water, -10 to -1.1C	51 d.	Frankland	1894
Proteus vulgaris			
Ice, 14-30F	103 d.	Hilliard	1918
Contaminated water, 14-30F	Inoc. 8,320/cc; Recov. 0, 51 d.	Prudden	1887
Water, -1C to -1.1C	51 d.	Frankland	1894
Pseudomonas pycyanea			
Ice, -5, -20, -70C	80%	Haines	1937
Pseudomonas fluorescens			
Contaminated, 14-30F	Inoc. innimerable, Recov. 85,008/cc; >7 d.	Prudden	1887

TABLE W 10 (CONT'D) THE SURVIVAL OF MICROORGANISMS IN WATER
(Klebsiella, Serratia, Proteus, & Pseudomona)

Factor(s)	Survival	Reference
SALINE SOLUTIONS		
PHYSIOLOGICAL		
Klebsiella pneumoniae		
85% NaCl	3½ mo.	Ballantyne 1930
Proteus sp.		
Saline	40 d.	Cramarossa 1927
Pseudomonas pyocyanea		
85% NaCl, 37C	30 3/4 mo.	Ballantyne 1930
" " R.T.	31¼ mo.	" "
Saline	85 d.	Cramarossa 1927
SEWAGE		
Pseudomonas sp.		
Ster. sewage, R.T.	7½ mo.	Rochaix 1930
OTHERS		
Serratia marcescens		
Seltzer, 10-17C	6-10 d.	Hochstetter 1887
Pseudomonas sp.		
Seltzer, 12-17C	11 d.	" "

TABLE W11 THE SURVIVAL OF MYCOBACTERIUM SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Mycobacterium tuberculosis			
Washings from children's hands, R.T.	0	Augustine	1929
Water	>21 d.	Bartel	1908
Running water	441 d.	Briscoe	1912
Water, winter	120 d.	Cadeac	1888
Tap	>1 yr.	Caussimon	1933
Ster. river, 8-12C	15 d.	Chantemesse	1888
Unster. " 15-20C	62 d.	"	"
River plus boiled sputum	Nothing	Gaustad	1947
Well and tap, 10½C	Inoc. 57,960-56,000; 6 d.	Kraus	1887
Water	Still virulent 3-3½ mo.	Loesener	1896
Water susp'n., 37C,	Inoc. 4-6 wk. serum cult. 1-4 d.	Moriya	1909
" " ice box	Inoc. 4-6 wk. serum " 52-142 d.	"	"
Canal, diffuse light, R.T., mixed with sputum	6½ mo.	Musehold	1900
Canal, dark	" "	"	"
" diffuse light all weather	4½ "	"	"
Myc. tuberculosis (avium)			
Stream	Inoc. 48,000/cc; Recov. 940/cc; 73 d.	Rhines	1935
Myc. paratuberculosis			
Intestinal scrapings with river, outdoor temp.	Recov. 163 d.	Lovell	1944
DISTILLED WATER			
Myc. tuberculosis			
Dist.	16 mo.	Ballantyne	1930
"	31½ mo.	"	"
" , 0-8C	21 3/4 mo.	"	"
Water dist.	>38 d.	Bartel	1908
Dist., 37C	<10 d.	Davies	1939
" "	Inoc. 4-6 wk. serum cult. 2-9 d.	Moriya	1909
" Ice box	Inoc. 4-6 wk. serum cult, 7-152 d.	"	"
Ster. dist., 15-20C	115 d.	Strauss	1889
Myc. paratuberculosis			
Dist., pond, tap, and mud	Recov. 9 mo.	Lovell	1944
ICE			
Myc. tuberculosis			
Dist. ice, dark	> 12 wk.	Gloyne	1928
Ice	12 wk.	"	"
SALINE SOLUTIONS			
PHYSIOLOGICAL			
Myc. tuberculosis			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
Isotonic NaCl 0.9%	>88 d.	Bartel	1908

TABLE W11 (CONT'D) THE SURVIVAL OF MYCOBACTERIUM SPECIES IN WATER

Factor(s)	Survival	Reference	
SALINE SOLUTIONS			
PHYSIOLOGICAL			
Myc. tuberculosis			
0.9% saline	< 4 d.	Davies	1939
Saline, R.T., dark	> 3½ mo. <5 mo.	Dudgeon	1914
0.8% NaCl, ice box	Inoc. 4-6 wk. serum cult. 21 d.	Moriya	1909
" " 37C	Inoc. 4-6 wk. " " 98 d.	"	"
" " ice box	Inoc. 4-6 wk. " " 152 d.	"	"
SEWAGE			
Myc. tuberculosis			
Sewage	Not given	Cummins	1929
" contaminated river	" "	Dudgeon	1914
Waste water, summer, dark	4 mo.	Honkanen	1947
" " winter, "	5 mo.	"	"
" " " light	4 mo.	"	"
Waste water from abattoir	Present	Jepsen	1940
Sewage, environmental	"	Jessen	1910
Canal liquid manure at R.T., diffuse light	6½ mo.	Musehold	1900
Canal liquid manure, all weather	6½ mo.	"	"
Canal liquid " R.T. dark	105 d.	"	"
Canal liquid manure and garden soil, exposed to noon sun	4 mo.	"	"
Canal liquid manure and garden soil, all weather	148 d.	"	"
Canal liquid manure, all weather and noon sun	60 d.	"	"
Sewage, 50C	Inoc. 830,000/ml, Recov. 840,000/ml, 1 hr.	Pramer	1950
" 37C	Inoc. 27, Recov. 35 coln. 35 d.	"	"
Polluted water, R.T., dark	3 mo.	Rhines	1935
Sewage	93 d.	Tanner	1944
Myc. avium			
Sewage	Inoc. 49,000/cc, Recov. 400/cc, 73 d.	Rhines	1935

TABLE ~~Lu~~ 2 FACTORS AFFECTING SURVIVAL OF ORGANISMS IN WATERS

Factors(s)	Survival	Reference	
NATURAL WATERS			
Deionized water more frequently regenerated the fever organisms		Eisman	1949
The action of the ultraviolet rays on bacteria is affected by the minerals in water		Gutfeld	1928
Drinking fountain drains had a count of 42,000/ml bacteria, inlets had 6,000/ml, outlets 7,000/ml.		Hitchens	1943
Terrestrial and fresh water bacteria tolerate changes in salinity and osmotic pressure better than marine		Korinek	1926
When coliform group is not found others may be present. Reasons why coliform group should not be used as indicators for sanitation. (1) Out breaks of enteric diseases associated with treated waters that had been found potable by coliform index. (2) Antagonistic effects of some strains of Shigella against coliforms. (3) Greater resistance of some viruses, Salmonella, Shigella, and Eberthella to chlorination than are some of colon groups. (4) Viruses of poliomyelitis and hepatitis in feces transmission of latter by water and typhus fever by ingestion. (5) Role of the non-lactose fermenting bacteria of the genera Salmonella, Shigella and possibly Proteus as inciters of enteric disease.		Levine	1947
The presence of coli aerogenes strain in chlorinated water in summer due to clumps of bacteria or protection of the organisms by some constituent of the water.		Levine	1939
Bacteria found in softeners usually slow down growing. Coliform found when city water supply neg.		Mallmann	-
Spore-bearing bacteria exposed to ultraviolet are killed as readily as others.		Schwarz	1911
Colon-typhoid group destroyed in high pH, limiting value 9.5.		Scott	1924
Bacteria in lake water found in greatest numbers in autumn and winter.		Taylor	1949
Stored bacteria in glass containers increase at high temp. and repressed at low.		"	"
Bacteria count reduced by mechanical dishwashers.		Ward	1939
Water 50cm deep in cylinders exposed to sun. Italian sun: Surface, Inoc. 4900, Recov. 0, 6 hr. Middle, " 4510 " 2 " " Bottom " 6781 " 8 " " Darkened cylinder: Surface, Inoc. 4900 " 7261, 6 hr. Middle " 4510 " 9051, " " Bottom " 6781 " 12591, " "		T. & W.	1946
ICE			
Dist., -16C	Shorter than sea water	Hess	1934

TABLE VII (CONT'D) FACTORS AFFECTING SURVIVAL OF ORGANISMS IN WATERS

Factor(s)	Survival	Reference
ICE (cont'd)		
Dust laden snow	4,370,000/g. deposit all but one spore former	Lochhead 1938
Clear ice contains fewer microbial forms and less soluble mineral matter than ice containing air bubbles.		Mc Farlane 1940
Snow and bubbly ice contain a greater number of bacteria than transparent ice from some block. Greater reduction shortly after.		Prudden 1887
The viability of typhoid is much stronger than V. cholerae. V. Cholerae dies after 10x repeated freezing.		Tohyama 1930
Snow: Achromobacter, Flavobacterium, and Micrococcus present.		Darling 1941
SALINE SOLUTIONS		
In Atlantic during May and June close to Portugal the number of bacteria increased and increased at night in surf and decreased in morning.		Bertel 1912
Sea water at -16C bacteria live longer than in broth or distilled water.		Hess 1934
400% sea water	Lethal	Johnson 1938
15% " "	No destruction of bact.	
300% - 350% sea water	Slow destruction of bact.	
Bacteria in stored sea water showed increase variation followed a population curve. Curve not affected by surface of water exposed but by volume of storage container.		Lloyd 1937
Bacteria at surf 25/cc, 25 meters depth 420/cc due to killing action of sunlight.		Schmidt-Nielson 1901
Bacteria of Salmonella group quickly die in sea probably due to protozoa. Below 20C protozoa have no effect.		Stryszak 1949
Relatively no bacteria in sea with plankton.		Velankar 1950
Fresh sea, 18-20C, Inoc. 2.5cc, Recov. 63.4, 56 d.		Waksman 1937
Heated sea, 18-20C, " " " 215, " "		" "
Artifical salt, 18-20C, Inoc. 2.5cc, Recov. 205, 56 d		" "
Berkefield filtered, Inoc. none, Recov. >1000, 14 d		" "
Bacteria does not survive long in sea.		Zobell 1936
Polluted sea found E. coli, Eberthella, (S. typhosa), V. cholerae, Salmonella and other enteric bacteria.		" 1942
Marine bacteria are much more thermosensitive than are terrestial bacteria.		" "
Bacteria in sea water and mud at 30C	25% killed in 10 min.	" 1940
Bacteria in sea " " mud at 40C	80% " " " "	" "
Sea - gram-neg. bacteria predominate in microflora.		" 1934
Terrestrial spp. in sea water at 30C growth reterded by 4500 lb. p.s.i. Deep sea more resistant than surface.		" 1949
Sea water, direct sun, depth of 10 mm.	Inoc. 163/cc, Recov. 126/cc, 2 hr.	" 1935

TABLE [illegible] (CONT'D) FACTORS AFFECTING SURVIVAL OF ORGANISMS IN WATERS

Factor(s)	Survival	Reference	
SALINE SOLUTIONS (cont'd)			
Sea water unexposed to sun	Inoc. 235/cc, Recov. 188/cc, 7 hr.	Zobell	1935
Sea water exposed to sun	Inoc. 246/cc, Recov. 198/cc, 7 hr.	Zobell	1935
SEWAGE			
Bacteria in sewage high count 2-6 d., maintained 6-15 wk.		Purdy	1918
Saprophytes must play a big part in disappearance of organisms in sewage after testing survival with sterile sewage.		Rochaix	1930
Putrifaction bacteria attack E. coli.		"	1931

TABLE W13 THE SURVIVAL OF PASTEURELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Pasteurella tularensis			
Water contaminated by infected animals	Not given	Ayres	1948
Streams in Canada	" "	Bow	1944
Water	1 yr.	Brown	1944
Streams	Not given	Falk	1947
River, 10-20C	" "	Glass	1948
Streams	Believed to be transmitted from mice to beavers	Jellison	1942
Water	Found over a period of 4 yr.	"	1950
Streams	48-72 hr.	Karpoff	1936
"	From bodies of infected animals	Lang	1947
"	Rats, mice are vectors	Maximov	1947
River	Contaminated by infected rabbits and infected man by fish fin	Miller	1939
Mountain streams	Guinea pig infected by inoc. from stream	Parker	-
River	Excreta of rats, mice, cats in drinking and washing water	Schuller	1943
Drinking water	Cl in larger doses than usual effective in killing tularemia	Steinhaus	1943
Contaminated cold	1 mo.	"	1945
Artificial contamination	11 wk.	"	"
Streams	Contaminated by excreta of mice	Zeiss	1943
DISTILLED WATER			
Pasteurella multocida			
Dist., 14-18C	½ hr.	Hochstetter	1887
Pasteurella hemolytica			
Dist. 37C	2¼ hr.	Jacotot	1926
Pasteurella multocida			
Dist., 37C	Up to 4.5 hr.	Panisset	1925
OTHERS			
Pasteurella multocida			
Seltzer, 14-18C	½ hr.	Hochstetter	1887

TABLE W14 THE SURVIVAL OF RICKETTSIA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Rickettsia			
Coxiella burneti			
Water, R.T.	7 d.	Babudieri	1950
Rickettsia prowazekii			
Well	Present	Mazurczak	1945
DISTILLED WATER			
Rickettsia prowazekii			
Dist., 26-28C	< 2 hr.	Anderson	1944
Tap and dist.	Deleterious effect on viability	Topping	1940
SALINE SOLUTIONS			
PHYSIOLOGICAL			
Rickettsia prowazekii			
Physiological saline	Deleterious effect on viability	Topping	1940

TABLE W15 THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
S. typhosa			
Tap	7 d.	Aitoff	1935
Boiled	30 d.	"	"
Tap, filtered, incubator temp., pH 5.9-6.2	31 d.	"	"
Tap, boiled, incubator temp., pH 5.9-6.2	69 d.	"	"
Rain, filtered, incubator temp., pH 5.9-6.2	93 d.	"	"
Rain, boiled, incubator temp, pH 5.9-6.2	86 d.	"	"
Well, outside temp., with E. coli	40 d.	Bartos	1947
Well, .36cc, R.T., pH 7.6 to 7.8	Inoc. 630 million, 31 d.	"	"
Well, .26cc, R.T., pH 7.2 to 7.4	" 2.6 " 10 d.	"	"
Well, .43cc, R.T., pH 7.8 to 6.0	" 1.1 " 13 d.	"	"
Well, R.T.	" 52.5 " 61 d.	"	"
Well slime, R. T.	" " " 71 d.	"	"
Tap, 20C	.7 d.	Bolton	1886
Tap, 35C	3 d.	"	"
Filtered impure well, 20C	23 d.	"	"
Unfiltered impure well	20-30 d.	"	"
Filtered impure well, 35C	5-10 d.	"	"
Water plus sunlight	1 hr. in thin layer	Clark	1902
" " "	5 hr. in bottles	"	"
Water, pH 3.8-8.7	6 hr.-48 hr. resptively	Cohen	1922
Well with unfiltered surface, 37C	Passed through 10 cults.	Crone	1951
Surface, 37C	Subcultured 10 times	"	"
Water, -10C to -1.1C	103 d.	Frankland	1894
Unster. river, 19-6C	34-40 d.	"	"
" " " "	Inoc. 74,000/cc (typhoid) 69,000/cc (coli), 75 d.	"	"
Steam ster. river	76 d.	"	"
Water	> few days	Greer	1928
Unster. cold	Prolángs	Hale	1910
" heated	Curtails	"	"
Tap	4-5 wk.	Hesse	1889
Tap	4 wk.	Hewlett	1905
River	2 wk.	"	"
Water	Death increases with temp.	Hinds	1932
Ster. tap	7 d.	Hochstetter	1887
Tap, 12-15C	7 d.	"	"
Aquarium	36 d.	Hoffman	1926
Med. at bottom of aquarium	2 mo.	"	"
Water	9 wk.	Houston	-
River, R.T., dark	8 wk.	"	1908

TABLE 14/15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
<u>S. typhosa</u>			
River	1 wk. gives 99% reduct.	Houston	1908
" cold	Prolongs	"	1911
" heated	Curtails	"	"
" uncultivated	3 wk.	"	1912
" Cultivated	5 wk.	"	"
" 0 C	Inoc. 103,328, 8 wk.	"	1913
" 5C	" " 6 wk.	"	"
" 10C	" " 4 wk.	"	"
" 18C	" " 3 "	"	"
" 27C	" " 2 "	"	"
" 37C	" " <2 wk.	"	"
Water, 0 C	8 wk.	"	1914
" 18C	3 wk.	"	"
" 37C	1 wk.	"	"
Ster. tap, R.T., dark	Inoc. 2-3 needles loops >93 d.	Jordan	1895
Steam ster. lake, dark	Inoc. 6435, 93 d.	"	"
Water	18 d.	"	"
Lake, 9-16C (tap)	Inoc. 1,000,085/cc, 6 d.	"	1904
Lake, 1.9C	" 2,200,000/cc, 7 d.	"	"
Ster. "	" 1,500,000/cc, >25 and <30 d.	"	"
Ster. (porcelain filt.) 20C	Inoc. 500/cc, 5 d.	"	"
Tap, 9-16C	" 540,000/cc, 6 d.	"	"
Raw tap 1.5-2.5C	" 3,000,000/cc, 6 d.	"	"
Ster. tap, 9-16C	1,000,000/cc, >15 d.	"	"
Chicago tap, 20C	Inoc. 500/cc, 2 d.	"	"
Filtered tap, 1-8C	" 1080/cc, 4 d.	"	"
Raw river, 12-14C	" 2,000,000/cc, 3 d.	"	"
Ster. river, 12-14C	" 1,500,000/cc, 2 d.	"	"
Water	6 d.	Karlinski	1889
Tap, R.T., in spleen	499 d.	Konradi	1904
" body, in "	542 d.	"	"
" R. T., in culture	490 d.	"	"
" body, in "	420 d.	"	"
Ster., R.T., in spleen	499 d.	"	"
" " in culture	490 d.	"	"
" body, in spleen	429 d.	"	"
" " " culture	30 d.	"	"
Unster. tap and river	4-6 d.	Kyriasides	1931
Well	13-16 d.	"	"
Ster. tap and river plus protozoa	2 d.	"	"
Mineral, pH 6.9	Inoc, 28000/cc, 18000/cc after 8 d.	Lieb	1947
" pH 6.0	Inoc. 32000 /cc, 120/cc after 8 d.	"	"
" " 6.8	Inoc. 2,000,000/cc; Recov. 128,000/cc, 14d.	"	"

TABLE W15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
S. typhosa			
Mineral, pH 6.8	Inoc. 2,000,000/cc; Recov. 150,000/cc; 14d.	Lieb	1947
" pH 7.1	Inoc. 200,000-300,000/cc Recov. 4/cc; 1 mo.	"	"
" pH 6.8	Inoc. 200,000-300,000/cc Recov. 200,000-300,000/cc; 14 d.	"	"
Ster., R.T.	8 mo.	Lomry	1929
" 37C	8 d.	"	"
Water or urine, outdoor temp.	20-40 d.	Lu	1933
Water or urine, indoors	Shorter time	"	"
Tap	7 d.	Mouzet	1936
Boiled	30 d.	"	"
Commercial spring, 20C	Inoc. 1,592,500; Recov. 340; 7 d.	Odst	1919
Ster.	Wks.	Osler	1901
Commercial spring, R.T.	Inoc. 1,383,000; " 520; 7 d.	Odst	1919
Water	77 d.	Park	1920
Well, 7-10C	Inoc. 2 mg. agar cult., 31 d.	Pfuhl	1902
Ice or cool water	40%-3 hr.; 98%-2 wk.	Prescott	1904
Ster.	2 mo.	"	"
Unster.	3 d.-several wks.	"	"
Streams, cold	Prolongs	Ruediger	1911
Streams, heated	Curtails	"	"
Open river	Inoc. 7,200,000; Recov. 232,000; 72 hr.	"	"
Lake	10 d.	Russell	1906
Water, 24C	<6 d.	Ruys	1897
" 6C	11 d.	"	"
" 1-12C, dark	Inoc. 26,000; Recov. 15500; 3 d.	"	"
" " " diffuse	Inoc. 26,000; Recov. 1, 3 d.	"	"
" 4C, refrigerator	Inoc. 26,000; Recov. 3800; 3 d.	"	"
Pond, 11-16C, light, surface of large vessel	Inoc. 45,000; 4 d.	"	"
Pond, 11-16C, light, bottom, of large vessel	Inoc. " Recov. 4; 4 d.	"	"
River, 6-10C, light, surface of large vessel	Inoc. 3500; Recov. 0, 4d.	"	"
River, 6-10C, light, bottom, of large vessel	Inoc. " " 800; 4 d.	"	"
Pond, dark, surface of small vessel	Inoc. 45000; Recov. 0, 4 d.	"	"
Pond, dark, bottom of small vessel	Inoc. 45000; Recov. 160; 4 d.	"	"

TABLE W15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
S. typhosa			
River, dark, surface of small vessel	Inoc. 35000, Recov. 18, 4 d.	Ruys	1897
River, dark, bottom of small vessel	Inoc. 35000, Recov. 1650 4 d.	"	"
River, light, 7-12C	Inoc. 7000/ml, Recov. 0, 5 d.	"	1941
" dark, " "	Inoc. 7000/ml, " 31 5 d.	"	"
Bath water from 12 tons of bath water after 500 people bathed	Inoc. 30,000 to 300,000/ cc. of water; survival not given	Tashiro	1932
Filtered, 20C	14 d.	Vacek	1933
Well, urine infected, 20C	>14 d., when other pathogenes are added time decreases	"	1933
Water, summer	12 d.	Watanabe	1930
" winter	18 d.	"	"
Tap, dark, 50-53F	Inoc. 1 drop cult., 21 d.	Wheeler	1907
" " 98-99F	" " " " 17 d.	"	"
" Light, 68-72F	" " " " 15 d.	"	"
" dark, " "	" " " " 43 d.	"	"
Ster. tap, aerobic	2 mo.	Whipple	1906
" " anaerobic	4 d.	"	"
Tap, 20C	Inoc. 1cc susp'n to 19cc water, Recov 0/cc, 47d.	"	"
River	99% reduct., 1 wk.	"	1922
Water, 32C	Inoc. 100,000/ml; Recov. 3/ml; 5 wk.	"	"
" 40C	Inoc. 100,000/ml; Recov. 3/ml; 4 wk.	"	"
" 50C	Inoc. 100,000/ml; Recov. 3/ml; 3 wk.	"	"
" 64.4C	Inoc. 100,000/ml; Recov. 3/ml; 2 wk.	"	"
Tap, rain, swimming pool	7-10 d.	Wibaut	1927
Ground water, protozoa	4 wk.	"	"
" "	>4 wk.	"	"
River plus tap, 30-35C, 12-15C, 10-7C	10-32 d.	Wolffhugel	1886
Filtered river, 35C	Recov. 2800, 5 d.	"	"
Well, 15-20C	Inoc. 5/500, Recov. 80, 1 d.	"	"
S. paratyphi A			
Tap	2 d.	Aitoff	1935
Boiled	10 d.	"	"
Tap, filtered, incubator temp., pH 5.9-6.2	50 d.	"	"
Tap, boiled, incubator temp., pH 5.9-6.2	" "	"	"
Rain filtered	86 d.	"	"
" boiled	47 d.	"	"

TABLE 11/13 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
S. paratyphi A			
Tap	2 d.	Mouzet	1936
Boiled	10 d.	"	"
S. paratyphi B			
Tap	22 d.	Aitoff	1935
Boiled	42 plus d.	"	"
Tap, filtered, incubator temp., pH 5.9-6.2	50 d.	"	"
Tap, boiled, incubator temp., pH 5.9-6.2	47 d.	"	"
Rain filtered	86 d.	"	"
" boiled	50 d.	"	"
Autoclaved buffered tap, 20C	Recov. 5x inoc.	Crone	1951
Surface, 37C	" 10x "	"	"
Well, 37C	" 3x "	"	"
Tap	24 d.	Mouzet	1936
Boiled	45 d.	"	"
S. paratyphi spp.			
Mineral	Inoc. 500 coli/1000cc 100paratyphoid/1000cc, 400 colonies/1000cc para sank to 6/1000cc	Lieb	1947
Water ster., R.T.	Up to 8 mo.	Lomry	1929
" " 37C	Up to 1 wk.	"	"
Unster., with E. coli	Several hr.	"	"
" with or without E. coli in dark	Plus after 1 mo.	"	"
Ster., R.T.	>8 mo.	"	"
" 37C	8 d.	"	"
S. typhimurium			
Well, outside temp.	Survival not given	Bartos	1947
" " " , with E. coli	30 d.	"	"
Well, R.T., pH 6.8-8.4	Inoc. 1103 million, Recov. 2, 12 d.	"	"
0.26cc well, R.T., pH 7.8	Inoc. 7.3 million, Recov 1, 8-10 d., none after 12 d.	"	"
1.03cc well, R.T., pH 7.8	Inoc. 22.5 million, Recov. 20, 7 d., none after 8 d.	"	"
Well, 37C	Recov. 3x inoc.	Crone	1951
Surface, 37C	" 10x "	"	"
DISTILLED WATER			
S. typhosa			
Distilled	11 d.	Aitoff	1935
Tap distilled, incubator temp., pH 5.9-6.2	31 d.	"	"
Distilled, 37C	3 wk.	Ballantyne	1930
"	14 mo.	"	"

TABLE W15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
DISTILLED WATER (cont'd)			
S. typhosa			
Distilled, 0-8C	22½ mo.	Ballantyne	1930
" R.T.	32 mo.	"	"
" 20C	14 d.	Bolton	1886
" 35C	3 d.	"	"
"	35 d.	Cramarossa	1927
Ster. distilled	5 d.	Hochstetter	1887
Distilled, 12-15C	½ hr.	"	"
" R.T., in spleen	499 d.	Konradi	1904
" " " culture	490 d.	"	"
Distilled, body temp., in spleen	429 d.	"	"
Distilled, " " " culture	420 d.	"	"
Distilled	3 mo.	McFarland	-
"	11 d.	Mouzet	1936
"	3 wk.	Muir	1903
"	Up to 62 d.	Panisset	1925
Steam ster. dist., 37C	Inoc. 48 hr. agar cult. 50 d.	Slater	1893
Ster. dist., 15-20C	81 d.	Strauss	1889
" "	6 mo. and 23 d.	Tanner	1944
Dist., 20C	7 d.	Vacek	1932
" 10-12C, dark	Recov. 1, 17 d.	Wheeler	1906
" 37C, dark	" 2, 27 d.	"	"
" 20-22C, light	" 2, 13 d.	"	"
" 50-53F, dark	Inoc. 1 drop cult., 17 d.	"	1907
" 98-99F, "	" " " " 15 d.	"	"
" 68-72F, light	" " " " 13 d.	"	"
" " " dark	" " " " 37 d.	"	"
S. paratyphi A			
Distilled	5 d.	Aitoff	1935
" , incubator temp. pH 5.9-6.2	42 d.	"	"
Dist.	23 d.	Cramarossa	1922
"	5 d.	Mouzet	1936
S. paratyphi B			
Dist.	32 d.	Aitoff	1935
" , incubator temp., pH 5.9-6.2	93 d.	"	"
Dist.	25 mo.	Ballantyne	1930
" , 0-8C	16 mo.	"	"
"	73 d.	"	"
"	32 d.	Mouzet	1936
Ster. dist.	8½ mo.	Tanner	1944
Dist., 60-142C,	Inoc. 16-20 hr. cult. & 6 cc. water, 1 hr.	Tinti	1923
ICE			
S. typhosa			
Ice	>8 mo.; 1% in 10 d.	Berry	1934

TABLE LWIS (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
ICE (cont'd)			
S. typhosa			
Ice	22 wk.	Hampil	1932
" , 0 C	>7 mo.	Hutchings	1903
" of filtered river, <0C	Inoc. 2,000,000/cc; 1 d.	Jordan	1904
Water, feces, urine; -8 to -30C, exposed to air	40-50 d.	Lu-Ti-Huan	1930
Ster. dist., -5C	1 wk - 14%; 22 wk.- 0%	Park	1901
River, 0C	Recov. <1%, 2 mo.	"	"
" 20-28F	" .004%, 16 wk.	"	"
Ice	Inoc. 410,000,000; Recov. 10,037,000; 14 d.	Ruedegir	1911
"	4 mo.	Park	1920
Contaminated water, 14-30F	Recov. 7,348/cc; 103 d.	Prudden	1887
Water, alternate freezing and thawing 5x	Inoc. 40,896/cc; 3 d.	"	"
Ice	99.9% reduction, 8 d.	Tanner	1944
" in capsule	Agar: recov. 17, 24 hr.	Wheeler	1906
" " "	Broth: " 0, 2 d.	"	"
" outside capsule	Agar: recov. 38, 2 d.	"	"
" " "	Broth: " 0, 2 d.	"	"
"	Inoc. 40,896/cc; Recov. 2,490/cc; 5 d.	Hilliard	1918
S. paratyphi spp.			
Ice	13 d.	Thomas	1925
S. paratyphi B			
Ice	17 d.	"	"
SALINE SOLUTION			
SEA			
S. typhosa			
Sea, filtered	Inoc. 300,000,000/cc; 32 d.	Beard	1935
" unfiltered	Inoc. 300,000,000/cc; 28 d.	"	"
" infected by ducks	Found	Bidwell	1950
" bouillon	Inoc. exclusively, 4 d.	De Giaxa	1889
" agar	" almost " , 9 d.	"	"
Ster. sea, bouillon	Inoc. 11800, 9 d.	"	"
" " agar	" 4800, 10 d.	"	"
Sea	1 d.	Gohar	1948
" autoclaved, Seitz filtered	32 d.	"	"
Sea, Seitz filtered	2 d.	"	"
" " " , autoclaved, pulp disc	5 d.	"	"
Sea, Seitz filtered, 60-100C	3 d. at 60C & 30 d. -100C	"	"
Sea	10 d.	Herdman	1899
Sea (oysters)	Inoc. 160,000,000; Recov. 320; 4 d.	Klein	1905

TABLE 15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
SALINE SOLUTION (cont'd)			
SEA			
S. typhosa			
Non-contaminated sea	16 d.	Trawinski	1929
Contaminated sea	3 d.	"	"
S. paratyphi A			
Sea, filtered Seitz	2 d.	Gohar	1948
"	1 d.	"	"
" autoclaved, Seitz filtered	32 d.	"	"
Sea, filtered, autoclaved and pulp disc	6 d.	"	"
Sea, Seitz filtered and heated to 60C	4 d.	"	"
Sea, Seitz filtered and heated to 100C	27 d.	"	"
Sea, non-contaminated	18 d.	Trawinski	1929
" contaminated	6 d.	"	"
S. paratyphi B			
Sea	12 d.	Trawinski	1929
" contaminated	" "	"	"
"	2 d.	Gohar	1948
" Seitz filtered	3 d.	"	"
" " " autoclaved	38 d.	"	"
Sea, Seitz filtered, autoclaved and pulp disc	6 d.	"	"
Sea, Seitz filtered, heated 60C	6 d.	"	"
Sea, Seitz filtered, heated 100C	30 d.	"	"
S. paratyphi sp.			
Sea non-contaminated,	16 d.	Trawinski	1929
" contaminated	" "	"	"
S. entertidis			
Sea non-contaminated	23 d.	"	"
" contaminated	5 d.	"	"
S. typhimurium			
Sea non-contaminated	21 d.	"	"
" contaminated	7 d.	"	"
PHYSIOLOGICAL			
S. typhosa			
85% NaCl	(1) 8 mo., (2) 5 mo.	Ballantyne	1930
" " , R. T.	32 mo.	"	"
Physiological salt, full radiation of mercury, under glass, cooled	30 sec.	Bazzoni	1914
Saline	32 d.	Cramarossa	1927
Ster. salt soln., 1-8C	Inoc. 1,080/cc, >10 d.	Jordan	1904
" " " 20C	" 900/cc, 2 d.	"	"

TABLE (N)15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
SALINE SOLUTION (cont'd)			
PHYSIOLOGICAL			
S. paratyphi A			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
Saline	33 d.	Camarossa	1927
S. paratyphi B			
85% NaCl, 37 C	13½ mo.	Ballantyne	1930
Saline	73 d.	Camarossa	1927
S. paratyphi sp.			
85% NaCl, R. T.	25 3/4 mo.	Ballantyne	1930
S. entertidis			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
SEWAGE			
S. typhosa			
Sewage and sludge	Inoc. 450,000/ml., 12 hr	Bruns	1927
Septic tank	2-3 d.	Flu	1921
Raw, R.T., north light	Inoc. 6,500,000; 3 d.	Green	1938
" outside, lower than R.T., pH 7.2-7.8	Inoc. 5 m.; 27 d.	"	"
Activated sludge, pH 6.8-7.6	Inoc. 37,500,000; >24 hr	"	"
Sewage in trickling filter	<½ hr.	"	"
River plus urine of typhoid cases, dark	99.9% reduction 1 wk.	Houston	1911
Water and feces, 1.9C	Inoc. 5,800,000/cc; <1 d.	Jordan	1904
Sewage, 14.5-17C	" 12,000/cc; <1 d.	"	"
Septic tank	5 d.	Kliger	1921
Sewage in river	Present	Lendon	1951
" of city	37 specimens out of 305	Messerschmidt	1951
Polluted	Disappeared more rapidly than in water or ice	Park	1920
Ster. sewage, R.T.	7½ mo.	Rochaix	1930
Activated sludge, aerated	Recov. 14%, 5½ hr.	Ruchhoft	1934
" " storage, 68-72F	" 0, 8-14 d.	"	"
Activated sludge, storage 50-60F	" 0, 83 d.	"	"
Sewage	5 d.	Russell	1906
" , winter	26 d.	Shimomura	1935
" summer	7 d.	"	"
Sewage, R.T.	Inoc. 1000/cc; neg. in 7 d.	Stewart	1933
Naturally infected sewage, R.T.	5 wk.	"	"
Dried sludge, 14% moisture	Inoc. 7,500,000/ml; 180d.	Stokes	1945
Sludge anaerobic	45 d.	"	"
Ster. sewage	3 mo. and 7 d.	Tanner	1944
Feces and water, 17-22.5C, weakly alkaline	Inoc. many; 96 hr.	Uffelman	1889
Feces and water, 9C, weakly alkaline	" " 24 hr.	"	"

TABLE W15 (CONT'D) THE SURVIVAL OF SALMONELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
SEWAGE (cont'd)			
S. typhosa			
Polluted spring, 43C	2 d.	Watanabe	1930
" well, dark, 10-12C	Recov. 1; 37 d.	Wheeler	1907
Polluted well, " 37C	" " 17 "	"	"
" " " 20-22C	" 50, 71 d.	"	"
Polluted well, light, 20-22C	" 1, 15 d.	"	"
Sewage (Belfast)	Isolated 10 out of 13x	Wilson	1931
" (Lisburn)	" 2x	"	"
Tap exposed to elements and inoc. with feces	3 wk.	"	1912
Anaerobic sludge	7 d.	Wolman	1924
S. paratyphi A			
Ster. sewage, R.T.	7½ mo.	Rochaix	1930
S. paratyphi B			
Sewage, 37C	24 hr.	Hecker	1948
" 9.5-12C	3 d.	Jordan	1904
Activated sludge	50% reduction after 1 hr	Pesch	1929
Ster. sewage, R.T.	7½ mo.	Rochaix	1930
" "	12 d.	Tanner	1944
Sewage (Belfast)	Isolated 2x	Wilson	1931
" , R.T., stored	3 wk.	"	"
S. paratyphi spp.			
Sewage of city	61 out of 305 specimens	Messerschmidt	1951
Sludge drying	Inoc. 25m/ml; 41 d.	Stokes	1945
S. entertidis			
Sewage of city	5 out of 305 specimens	Messerschmidt	1951
OTHERS			
S. typhosa			
Seltzer, 12-15C	4 d.	Hochstetter	1887
" 7-10C	Inoc. a suspn. of agar cult., 15-27 d.	Pfuhl	1902

TABLE W16 THE SURVIVAL OF SHIGELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Sh. dysenteriae			
Tap	4 d.	Aitoff	1935
Boiled	11 d.	"	"
Well, outside temp., with E. coli	30d.	Bartos	1947
Well, R.T., pH 7.2-7.8	Inoc. 2-12 million, 11-18 d.	"	"
Water, ster.	24 d. after inoc.	Dudgeon	1919
River	Many hr.	"	"
Ster. tap, R.T.	Inoc. 11 standard strain 6 mo.	Felsen	1945
Ster., 17-20C	Rarely more than a wk.	Frost	1905
Water and earth, winter	Failed to isolate growth	Hampil	1932
Raw lake	Inoc. 22,000/cc, 2 d.	Jordan	1904
Tap	" " " "	"	"
Raw river	" 700,000/cc, 3 d.	"	"
Heated well, R.T.	71 d.	Karlinski	1907
Unster., R.T.	42 d.	"	"
Well, 10-12C	56 d.	"	"
Tap	27 d.	Kusama	1925
Water or urine	40-50 d.	Lu-Ti-Huan	1933
Tap	4 d.	Mouzet	1936
Boiled	11 d.	"	"
Spring, high in minerals or organic matter, 20C	Inoc. 6,550,000; 18 d.	Odst	1919
Spring, high in minerals or organic matter, R.T.	" 1,350,000; " "	"	"
Well, 7-10C	Inoc. 2mg. agar cult., 9 d.	Pfuhl	1902
Well, R.T.	Inoc. 2mg. " " 5 d.	"	"
Well, 37C, R.T., 3C	Longer at lower temp.	Steuer	1941
Ster.	30 d.	Tashira	1932
Water, 1-14C	10-13 d.	Vincent	1917
Impure, 22-28C	2-5 d.	"	"
Sh. paradysenteriae (Flexner)			
Tap	16 d.	Aitoff	1935
Boiled	22 d.	"	"
Tap	16 d.	Mouzet	1936
Boiled	22 d.	"	"
Water	38 d.	Stewart	1944
Sh. paradysenteriae (Sonne)			
Well, outside temp., with E. coli	30 d.	Bartos	1947
Well, R.T., pH 7.2-7.8	Inoc. 12 million, 18 d.	"	"
Tap, with 0.15 p.p.m. residual Cl.	Found	Freen	1943
DISTILLED WATER			
Sh. dysenteriae			
Dist.	15 d.	Aitoff	1935
"	7-73 d.	Cramarossa	1927

TABLE ~~III~~ B (CONT'D) THE SURVIVAL OF SHIGELLA SPECIES IN WATER

Factor(s)	Survival	Reference	
DISTILLED WATER			
Sh. dysenteriae			
Dist.	18 d.	Kusama	1925
"	15 d.	Mouzet	1936
" , 60-142C,	Inoc. 16-20 hr. cult. in 6cc. water, 1 hr.	Tinti	1923
Sh. paradysenteriae (Flexner)			
Dist.	24 d.	Aitoff	1935
"	7-73 d.	Cramarossa	1927
"	24 d.	Mouzet	1936
ICE			
Sh. dysenteriae			
Ice from ster. water	2 mo.	Felsen	1945
Water, feces, urine; -8 to -30C	55 d.	Lu-Ti-Huan	1930
Ice	41-68 d.	Vincent	1917
SALINE SOLUTIONS			
SEA			
Sh. dysenteriae			
Filtered sea	2-5 mo.	Felsen	1945
Contaminated and non-contaminated sea	30 hr. and 12 hr.	Trawinski	1929
Sh. paradysenteriae spp.			
Sea	1 d.	Gohar	1948
" , Seitz filt.,	2 "	"	"
" " " autoclaved	32 d.	"	"
Sea, Seitz filt., autoclaved, pulp disc	4 d.	"	"
Sea, Seitz filt. heated 60C	3 d.	"	"
Sea, Seitz " " 100C	28 d.	"	"
PHYSIOLOGICAL			
Sh. dysenteriae			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
0.8% salt soln.	12-53 d.	Cramarossa	1927
Sh. paradysenteriae (Flexner)			
0.8% salt soln.	12-53 d.	Cramarossa	1927
Saline	35 d.	"	"

TABLE W17 THE SURVIVAL OF STREPTOCOCCUS SPECIES IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
S. agalactiae			
Tap	66 d.	Bryan	1934
S. pyogenes			
Deep well	11 d.	Livingston	1921
Surface well	8 d.	"	"
Lake	7 d.	"	"
Street, autoclaved	6 d.	"	"
River	" "	"	"
Country roadside ditch	5 d.	"	"
Street not ster.	4 d.	"	"
Park lagoon	4 d.	"	"
Tap	3 d.	"	"
Chicago river	2 d.	"	"
Water, 37.5C	Inoc. 10,000/cc; 6 d.	"	"
" 27C	" " " 9 d.	"	"
" 1C	" " " 15 d.	"	"
S. faecalis			
Swimming pool plus Cl	1 hr.	Ritter	1948
S. salivarius			
Swimming pool plus Cl	5 min.	"	"
S. enterococcus			
Tap without Cl	> 12 hr.	"	"
S. spp.			
Water (phys)	3 hr.	Belin	1933
" " , 50C	1 hr. 10 min.	"	"
" " 44-45C	10.5 hr.	"	"
" " 55C	1.5 hr.	"	"
Open reservoirs	4 d.	Holwerda	1928
Covered reservoirs	8 d.	"	"
DISTILLED WATER			
S. pyogenes			
Ster. dist., R.T., subdued light	3-87 d.	Livingston	1921
S. mitis			
Dist.	21 3/4 mo.	Ballantyne	1930
" , 0-8C	25 mo.	"	"
S. spp.			
Dist.	Not given	Gilcreas	1950
"	4-7 d., K value 0.736 81.6% reduction/day	Heller	1941
" , 37C	Upto 74 d.	Panisset	1925
Ster. dist., 15-20C	15 d.	Strauss	1889
SALINE SOLUTION			
PHYSIOLOGICAL			
S. mitis			
85% NaCl, 37C	13½ mo.	Ballantyne	1930
S. pyogenes			
Saline	12 d.	Livingston	1921
S. spp.			
Saline	K value 0.537, 70.9%/d.	Heller	1941
SEWAGE			
S. spp.			
Feces plus natural water	7 d.	Savage	1917
Polluted water	Twice that of typhoid & coli	Smit	1931

TABLE W18 THE SURVIVAL OF VIBRIO COMMA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS			
Vibrio comma			
Tap	2 d.	Arguelles	1927
Ster. tap	6-10 d.	"	"
Water, 10 atm. carbon dioxide	< 10 hr.	Colin	1915
Ster. spring	7 mo.	D'Herelle	1930
River, filtered	> 1 yr.	"	"
Tap	56-66 d.	"	"
Ster. water	7-8 d.	"	"
Water of aquarium	3 mo.	"	"
Well	62 d.	"	"
Raw water	1-24 d.	"	"
Well	72 hr.	Emmerich	1889
Potable water, filtered river, deep well	3 wk.	Frankland	1886
Ster. tap	Inoc. 149,500; Recov. 0, 18 d.	Gelarie	1816
Native tap	Inoc. 149,500; Recov. 0, 3 d.	"	"
Ster. bay	Inoc. 149,500; " " 154 d.	"	"
Native bay	Inoc. 149,500; " " 21 d.	"	"
Water	< 5 wk.	Haffkine	1895
River, filtered	Inoc. 5,500; 3 hr.	Hankin	1896
" boiled	" 6,000; 49 hr.	"	"
" both	" 7,000; 25 hr.	"	"
Well, filtered	" 8,500; 49 hr.	"	"
" boiled	" 7,500; " "	"	"
River, filtered	" 4,200; 2 hr.	"	"
Up river, filtered	Inoc. 1,200; 1-2 hr.	"	"
Down stream	" 1,500; 1 hr.	"	"
River, near old cadaver	Inoc. 1,250; 1-2 hr.	"	"
" " recent "	" 2,000; 1-5 hr.	"	"
Up stream, boiled	" 1,250; 48 hr.	"	"
Well	" 1,200; 48 hr.	"	"
Tap	4-5 wk.	Hesse	1889
"	391 d.	Hochstetter	1887
Raw river	99.9% 1 wk., 0 - > 2 wk.	Houston	1909
River, lab conditions	99% in 3 d.	"	1910
"	8 d.	Kahn	1929
Well	12 d.	"	"
River, boiled	3 d.	"	"
Raw river	< 24 hr.	"	1930
Boiled water, 5 min. open	< 72 hr.	"	"
" " " " sealed	< 72 hr.	"	"
Filtered	< 48 hr.	"	"
Heated 55C for ½ hr.	< 72 hr.	"	"
Open boiled and vapor from raw water at 80C for 15 min	< 72 hr.	"	"

TABLE W18 (CONT'D) THE SURVIVAL OF VIBRIO COMMA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
Vibrio comma			
Opened boiled plus vapor from raw water at 90C for 15 min.	11 d.	Kahn	1930
Heated at 50C for 15 min.	< 24 hr.	"	"
" " 80C " " "	< 120 hr.	"	"
" " 90C " " "	< 96 hr.	"	"
Water	72 hr.	Karlinski	1889
Spring	30 d.	Koch	1886
Well and tap, 10½C	Inoc. 10,100-8,700; Recov. 0, 24 hr.	Kraus	1887
Unster. tap and river	4-6 d.	Kyriasides	1931
Well	13-16 d.	"	"
Ster. tap and river plus protozoa	2 d.	"	"
Hill spring, untreated, raw	1 hr.	Lahiri	1939
Hill spring, autoclaved, raw	18 hr.	"	"
Calcutta tap, untreated, raw	18 hr.	"	"
Calcutta tap, untreated, filt.	2 d.	"	"
Calcutta tap, autoclaved, raw	24 hr.	"	"
Calcutta tap, " filtered	12 d.	"	"
River, untreated, raw	18 hr.	"	"
" " filtered	2 d.	"	"
" autoclaved, raw	3 d.	"	"
" " filt.	2 d.	"	"
Dulhousie sq. tank, untreated, raw	48 hr.	"	"
Dulhousie sq. tank, untreated, filt.	7 d.	"	"
Dulhousie sq. tank, autoclaved, raw	3 d.	"	"
Dulhousie sq. tank, " claved, filt.	15 d.	"	"
Norheldanza & Vetudanza tank, untreated, raw	72 hr.	"	"
Norheldanza & Vetudanza tank, untreated, filt.	7 d.	"	"
Norheldanza & Vetudanza tank, autoclaved, raw	12 d.	"	"
Norheldanza & vetudanza tank, autoclaved, filt.	18 d.	"	"
Water or urine	2 d.	Lu-Ti-Huan	1933
River, unconc.	41 out of 66 samples	Panja	1947
" conc.	23 out of 66 samples	"	"
Natural (Assam)	90.5-95% positive	Pandit	1938

TABLE LWIY (CONT'D) THE SURVIVAL OF VIBRIO COMMA IN WATER

Factor(s)	Survival	Reference	
NATURAL WATERS (cont'd)			
Vibrio comma			
Artifical water plus salt and organic matter for growth	>3 wk.	Read	1939
Tap, 25C	56 d.	Schobel	1914
Ster., 25-27C	7 d.	"	"
" soda water	Inoc. agar cult. 48 hr. 37C; 10 d.	Slater	1893
River and tap, 30-25, 12-15, 7-10C	15 d.	Wolffhugel	1886
River and tap and well	8 d.	Yasuhara	1926
DISTILLED WATER			
Vibrio comma			
Ster. dist.	<1 d.	Argelles	1927
Dist.	29 d.	Camarossa	1922
" plus $CuSo_4$ 1/50M	1 hr.	Ficker	1898
"	Inoc. 4,500; 24 hr.	Hankin	1896
"	34 hr.	Hochstetter	1887
" river	< 24 hr.	Kahn	1929
Ster. dist., 15-20C	39 d.	Strauss	1889
" "	6 mo. & 23 d.	Tanner	1944
Dist.	Short	Wolffhugel	1886
ICE			
Vibrio comma			
Water, -8 to -30C	1 d.	Lu-Ti-Huan	1930
Ster. salt water, 0.5-0.7C	Recov. 0, 6-7 d.	Renk	1893
Ster. salt water, 0.5-0.7C	Inoc. 1,483,000/cc; Recov. 62,445.cc; 24 hr.	"	"
SALINE SOLUTION			
SEA			
Vibrio comma			
Sea	12 d.	Arguelles	1927
" , on bouillon, 37C	Inoc. 1,000; 4 d.	DeGiaxa	1889
" " agar, 37C	" 8/10; 2 d.	"	"
" ster., on bouillon, 37C	" exclusively, 5 d.	"	"
Sea, ster., on agar, 37C	" very few, 1 d.	"	"
Sea	4-122 d.	D'Herelle	1930
Bay, ster.	Inoc. 149,500; 154 d.	Gelarie	1916
" native	" " 21 d.	"	"
Sea, 18C, autoclaved	32 d.	Gohar	1948
" autoclaved and paper filt.	26 d.	"	"
Sea, Seitz filt.	1 d.	"	"
" " " , autoclaved, pulp disc	5 d.	"	"
Sea, filt., ster. bact. suspn.	3 d.	"	"
Sea and sewage, 18C	24 hr.	"	"
Synthetic sea	26 d.	"	"

TABLE W1 (CONT'D) THE SURVIVAL OF VIBRIO COMMA IN WATER

Factor(s)	Survival	Reference
SALINE SOLUTION		
SEA		
Vibrio comma		
Boiled sea	Lives longer than in raw	Kiribazeuski 1934
Sea direct sun	8 hr.	Matsuda 1910
Ster. sea, 25-27C	106 d.	Schobel 1914
Sea,	5 d.	Tohyama 1925
" 20C	24 hr.	" "
Bay, 1-5C	11 d.	Yasuhara 1926
Sea and river	13 d.	" "
Sea, 30-18C	Inoc. 300,000/cc water, After 4 hr. decreased 99.8%, after 6 hr. slow increase	Yasukawa 1933
Sea, 36-20C	After 1 hr. decreased 86%, 2 hr. 91.7%; 6 hr. increased slow	" "
Surface	23 d.	" "
Center	22 d.	" "
Bottom	29 d.	" "
PHYSIOLOGICAL		
Vibrio comma		
Sat. soln. of NaCl	Less than 1 d.	Arguelles 1927
Saline	36 d.	Cramarossa 1927
SEWAGE		
Vibrio comma		
Sewage	24-48 hr.	D'Herelle 1930
Septic tank	24 hr.	Flu 1921
Sewage	Capable of enormous mult.	Frankland 1886
" , Seitz filtered, pH 6.5	23 d.	Gohar 1948
Sewage, autoclaved, pH 7.5	26-29 d.	" "
Sewer	6-7 d.	Koch 1886
Cesspool	< 24 hr.	" "
Ster. sewage	7½ mo.	Rochaix 1930
" "	3 mo. 7 d.	Tanner 1944
OTHERS		
Vibrio comma		
Seltzer water, 18C	2½ hr.	Hochstetter 1887

TABLE 449 THE SURVIVAL OF VIRUS IN WATER

Factor(s)	Survival	Reference
NATURAL WATERS		
Polio		
Tap, ice box	100 d.	Carlson 1942
" direct sunlight	Inoc. 1:100 dil., 30-45 min.	" "
Water	None	Francis 1948
Tap, dark, R.T.	114 d.	Kling 1929
Susp'n of monkey cord added to water, R.T	1 mo	Landsteiner 1911
Natural water, pH 7.9 - 8.3, and 10-11.25, 0.05 ppm. residual free Cl and .1-.15	10 mo.	Lensen 1949
Several lakes, 18-25.3C, pH 7.42-8.25, 0.05 ppm. residual Cl	Inoc. 0.25%, <10 min.	" "
River, 20-23C, pH 7.8-8.2, 0.05 ppm. free residual Cl, after 5 min. contact	Inoc. 0.25%, 10 min.	" "
Lime treated well, 21-26C, pH 8.0-10.5, traces of residual Cl after 5 min contact	Inoc. 0.25%, >1 hr. 0.5%, 1 hr.	" "
Creek water,	Infected by the cotton rat	Toomey 1945
Lymphocytic choriomeningitis		
Chlorinated drinking water, R.T.	7,3,4 d.	Zichis 1948
Western equine encephalitis		
Chlorinated drinking, R.T.	5,2,4 d.	" "
St. Louis encephalitis		
Chlorinated drinking, R.T.	4,3,2 d.	" "
DISTILLED WATER		
Yellow fever		
Dist., ice box	10 yr.	Bauer 1940
Polio		
Dist., pH 6.85-7.4, 0.05 ppm. residual free Cl	10 min.	Lensen 1949
Vaccinia virus		
Dist., 18-37C	60 d.	Noguchi 1918
SEWAGE		
Polio		
Sewage, 70F	Reg. at 5-14 d.	Evans 1946
Stool fresh	Present	Francis 1948
Sewage, 4C	2-3 mo.	Kling 1942
"	Activated sludge and chlorination effect	Krumbiegel 1944
Stool plus water and oro-nasopharyngeal secretion	Inactivated 30 min.	Faber 1951
Domestic sewage	Present	Maxcy 1949
Sewage of polio victims and carriers	Possibly hr.	" 1943

TABLE W19 (CONT'D) THE SURVIVAL OF VIRUS IN WATER

Factor(s)	Survival	Reference	
SEWAGE			
Polio			
Raw, hosp. (polio) sewage, residential sewage	Present in late summer and fall	Melnick	1947
Stool plus river, 4C, pH 7.98, dark	188 d.	Rhodes	1950
Activated sludge in am't as low as 1100 ppm.	Non-effective after 6 hr. aeration	Ridenour	1943
Sewage	Present when cases are reported	Trask	1942

TABLE W20 THE SURVIVAL OF YEASTS AND FUNGI IN WATER

Factor(s)	Survival	Reference
NATURAL WATERS		
Aspergillus		
Tap, 12-17C	56 d.	Hochstetter 1887
DISTILLED WATER		
Aspergillus		
Dist., 12-17C	56 d.	Hochstetter 1887
Cladosporium mansoni		
Dist., R.T.	12 mo.	Castellani 1939
Aleurisma castellanii		
Dist., R.T.	" "	" "
Actinomyces sp.		
Dist., R.T.	" "	" "
Monilia sp.		
Dist., R.T.	" "	" "
Geotrichum sp.		
Dist., R.T.	" "	" "
Epidermophyton flaccosum		
Dist., R.T.	" "	" "
ICE		
Saccharomyces sp.		
Dist.,-21 to -78C	Inoc. 10,000-100,000/ml. More resistant to freezing than thawing	Lund -
" -10C, pH 6.5	Inoc. 550,000/cc; Recov. 68.2%; 28 wk.	McFarlane 1941
" -20C, " "	Inoc. 550,000/cc; " 70.9%; 28 wk.	" "
" -10C, " 5	Inoc. 455,000/cc; " 99.5%; 28 wk.	" "
" -20C, " "	Inoc. 455,000/cc; " 80.7%; 28 wk.	" "
" -10C, " 3.7	Inoc. 500,000/cc; " 99%; 15 wk.	" "
" -20C, " "	Inoc. 500,000/cc; " 93.2%; 15 wk.	" "
OTHERS		
Aspergillus		
Seltzer, 12-17C	56 d.	Hochstetter 1887

References (Water)

1. Aitoff, M., and Dobkevitch, H. 1935 Survival of intestinal bacteria in water. Compt. rend. soc. biol., 119, 1080-1083.
2. Aitoff, M., and Dobkevitch, H. 1935 Rhythm of disappearance of certain intestinal bacilli (typhoid group) from different kinds of water. Compt. rend. soc. biol., 119, 1272-1274.
3. Albert, H. Hinman, J.J., Jr., and Jordan, G. 1917 Bacterial changes in uniced specimens of water and description of container for transportation of iced specimens of water for both chemical and bacteriological examination. Am. J. Pub. Health, 7, 1010.
4. Allen, L.A., Brooks, E., and Williams, I.L. 1949 Effect of treatment at the sewage works on the numbers and types of bacteria in sewage. J. Hyg., 47, 303-319.
5. Anderson, C.R. 1944 Survival of rickettsia in different diluents. J. Bact., 47, 519.
6. Anonymous 1921 Thirty-third Annual Rept. of the Louisiana Agric. Exp. Station.
7. Arguelles, M.V. 1927 Viability of cholera vibrio in various menstrua. Rev. Filipina de Med. y Farm., 18, 137-140.
8. Arloing, F., and Dufourt, A. 1931 Autopurification of river water. Compt. rend. soc. biol., 106, 192-194.
9. Arloing, F., Sempe, N.I., and Chavanne, N.I. 1925 Proprietes antimicrobiennes de diverses eaux fluvines ou marines. Pouvoir bacteriophagique. Bull. acad. med., Paris, 93, 184-187.
10. Arnold, L. 1925 The significance of bacteriophage in surface water. Am. J. Pub. Health, 15, 950.
11. Arthur, D. 1894-1895 Bacteriology of sewer air. San. Rec., London, 16, 1160-1162.
12. Atkinson, N. 1934 The occurrence of aerobacter aerogenes in sewage and feces. Australian J. Exp. Biol. Med. Sci., 12, 141-149.
13. Augustine, A.E. 1929 The transfer of tuberculosis by dust and other agents. J. Prevent. Med., 3, 121-138.
14. Ayres, J.C. 1948 Epidemiology of tularemia in Massachusetts with a review of the literature. New England J. Med., 238, 187-194.
15. Babudieri, B., and Moscovici, N.I. 1950 Richerche sul comportamento di Coxiella burneti di fronte ad alcuni agenti fisici e chimici. Rend. Ist Superiore Sanita, Rome, 13, 739-748.
16. Ballantyne, E.N. 1930 On certain factors influencing the survival of bacteria in water and in saline solutions. J. Bact., 19, 303-320.
17. Bang, B. 1897 Die Aetiologie des seuchenhaften (infectiosen) Verwerfens. Z. Thier., 1, 241-278.
18. Bartel, J., and Neumann, W. 1908 Das Verhalten der Tuberkelbacillen in "indifferenten" Flussigkeiten. Centr. Bakt. 1 Abt., Orig., 47, 401-414, 572-579.
19. Bartos, D., Bansagi, J., and Bakos, K. 1947 Survival time of pathogenic enteric bacteria in well water. Z. Hyg. Infektionskrankh., 127, 347-354.

20. Basset, J., and Macheboeuf, M.A. 1932 Resistance of bacteria to very high pressure. Compt. rend. acad. sci., 195, 1431-1433.
21. Bauer, J.H., and Pickels, E.G. 1940 An apparatus for freezing and drying virus in large quantities under uniform conditions. J. Exp. Med., 71, 83-88.
22. Bazzoni, C.B. 1914 The destruction of bacteria through the action of light. Am. J. Pub. Health, 4, 975-992.
23. Beard, P.J., and Meadowcroft, N.F. 1935 Survival and rate of death of intestinal bacteria in sea water. Am. J. Pub. Health, 25, 1023-1026.
24. Beaver, P.C., and Deschamps, G. 1949 The viability of E. histolytica cysts in soil. Am. J. Trop. Med., 29, 189-191.
25. Becker, E.R., Burks, C., and Kalieta, E. 1946 Cultivation of Endamoeba histolytica in artificial media from cysts in drinking water subjected to chlorination. Am. J. Trop. Med., 26, 783.
26. Beckwith, T.D., and Rose, E.J. 1930 Bacteriophage content of sewage; action upon bacterial organisms. J. Bact., 20, 151-159.
27. Belin, M., Mutermilch, S., and Salamon, E. 1933 Effect of protective subsrances on heat resistance of certain bacteria. Compt. rend. soc. biol., 114, 1278-1281.
28. Benetson, B.N. 1925 Viability of gonococci in water. Illinois Med. J., 47, 296-298.
29. Berry, A.E. 1934 Ice supplies and associated health problems. Canadian Pub. Health J., 25, 321-325.
30. Bertel, R. 1912 Sur le distribution quantitative des bacteries planctoniques des cotes de Monaco. Bull. Inst. Oceangr. Monaco, No. 224.
31. Bidwell, M.H., and Kelly, C.B. 1950 Ducks and shellfish sanitation. Am. J. Pub. Health, 40, 923-928.
32. Bigger, J.W. 1934 The growth of coliform bacilli in water. Brit. Med. J., 2, 919.
33. Bigger, J.W., and Nelson, J.H. 1941 Growth of coliform bacteria in distilled water. J. Path. Bact., 53, 189-206.
34. Boeck, W.C. 1921 On the longevity of human intestinal protozoan cysts. Am. J. Hyg., 1, 527.
35. Bogolyubov, K.K. 1946 The nature of the bactericidal factor in water. Gigiena i Sanit., 11, 12-15.
36. Boldue, N.I. 1935 Canadian Pub. Health J., 26, 215.
37. Bolton, M. 1886 Uber das Verhalten verschiedener Bacterienarten im Trinkwasser. Z. Hyg., 1, 76-114.
38. Bow, M.R., and Brown, J.H. 1944 Water-borne tularemia in Western Canada. Canadian Med. Assoc. J., 50, 14-16.
39. Briscoe, L.F. 1912 Fate of tubercle bacilli outside the animal body. Illinois Agr. Exp. Sta. Bull., No. 161.
40. Brown, J.H. 1944 The susceptibility of fur-bearing animals and game birds to tularemia. Canadian Field Naturalist, 58, 55-58.
41. Brown, R.F. 1947 Up-sewer cloroben treatment of Los Angeles sewage. Water and Sewage Works, 94, 181-186.
42. Brown, L., Petroff, S.A., and Heise, F.H. 1916 Tuberculosis bacillus living in river water contaminated by sewage from health resort. Am. J. Pub. Health, 6, 1148-1152.

43. Bruns, H., and Sierp, F. 1927 The effect of the activation of sewage sludge on pathogenic organisms. Z. Hyg. Infektionskrankh., 107.
44. Bryan, C.S. 1934 The viability of streptococci of mastitis. Vet. Med., 29, 524-526.
45. Buchanan, G. 1927 Spec. Rept. Ser. Med. Research Coun., London, No. 113.
46. Buchner, H. 1892 The effect of light on bacteria. Centr. Bakt., 11, 781-783.
47. Bujwid, O. The action of ultraviolet rays upon bacteria. J. Gasbel., 54, 853-863.
48. Burke, V., and Baird, L.A. 1931 Fate of fresh-water bacteria in the sea. J. Bact., 21, 287-298.
49. Burke, V., and Taschner, L. 1936 Growth of Escherichia coli in a small amount of organic matter. J. Bact., 32, 124-125.
50. Butterfield, C.T. 1928 Experimental studies of bacterial death rates in polluted waters. J. Bact., 16, 257-267.
51. Butterfield, C.T. 1933 Observations on changes in numbers of bacteria in polluted water. Sewage Works J., 5, 601-622.
52. Butterfield, C.T., and Wattie, E. 1946 Influence of pH and temperature on the survival of coliforms and enteric pathogens when exposed to chloramine. U.S. Pub. Health Repts., 61, 157-193.
53. Cadeac, N.I., and Malet, N.I. 1888 Research experiments on the virulence of purulent matter, dried, putrified or frozen. Congres pour l'etude de la Tuberc., 314.
54. Caldwell, M., and Parr, L. 1933 J. Am. Water Works, 25, 1107.
55. Carlson, H.J., Ridenour, G.M., and McKhann, C.F. 1942 Efficacy of standard purification methods in removing poliomyelitis virus from water. Am. J. Pub. Health, 32, 1256-1262.
56. Carlson, H.J., Ridenour, G.M., and McKahnn, C.F., Jr. 1943 Effect of activated sludge process of treatment on poliomyelitis virus. Am. J. Pub. Health, 33, 1083-1087.
57. Castell, C.H., and McDermott, L.A. 1942 Multiplication of bacteria in water and its significance in food spoilage. Food Research, 7, 244-253.
58. Castellani, A. 1939 Viability of some pathogenic fungi in distilled water. J. Trop. Med., 42, 225-226.
59. Catalano, G. 1947 Sopravvivenza e fenomeni di variazione del B. coli in ambiente idrico. Riv. Ital. Igiene, 7, 284-296.
60. Caussimon, J. 1933 Tubercle bacilli culture on ordinary water and distilled water. Compt. rend. soc. biol., 112, 577-578.
61. Chamberlain, W.P., and Vedder, E.B. The effect of ultraviolet rays on amoebae, and the use of these radiations in the sterilization of water. Philippine J. Sci., 6, 383-394.
62. Chang, S.L. 1950 Kinetics in the thermodestruction of cysts of Endamoeba histolytica in water. Am. J. Hyg., 52, 82-90.

63. Chang, S.L., Willner, M., and Tegarden, L. 1950 Studies on destruction of bacterial virus. II. Kinetics in the thermodestruction of bacterial virus (bacteriophage against Escherichia coli) in water. Am. J. Hyg., 52, 194-201.
64. Chang, S.L., Buckingham, M., and Taylor, M.D. 1948 "Studies of Leptospira icterohaemorrhagiae. IV. Survival in water and sewage: destruction in water by halogen compounds, synthetic detergents and heat." J. Infectious Diseases, 82, 256.
65. Chantemesse, N.I., and Vidal, N.I. 1888 Resistance des germes de la tuberculose dans l'eau de viviere. Congres pour l'etude de la Tuberculose, 317.
66. Chapman, E.N. 1935 Sewage contaminated irrigation water. Am. J. Pub. Health, 25, 930.
67. Christiansen, M.J. 1950 Graesmarksinfektion og kvaegbrucellose. Kastningsbakteriers levedygtighed i det fri, belyst ved praktiske forsøg. Maanedsskr. Dyrlaeger, 61, 253-288.
68. Christomanos, A.C. 1898 Ueber einige Eigenschaften des künstlichen Eises. Oesterreichische Chemiker-Zeitung.
69. Clark, H.W., and Gage, S. de M. 1902 Annual Report Mass. State Bd. Health.
70. Cohen, B. 1922 Disinfection studies. The effects of temperature and hydrogen-ion concentration upon the viability of B. coli and B. typhosus in water. J. Bact., 7, 183-230.
71. Colin, N.I. 1915 Compt. rend. acad. sci., 161, 652-655.
72. Cox, K.E., and Claiborne, F.B. 1949 Effect of age and storage temperature on bacteriological water samples. J. Am. Water Works Assoc., 41, 948-952.
73. Cram, E.B. 1943 The effect of various treatment processes on the survival of helminth ova and protozoan cysts in sewage. Sewage Works J., 15, 1119-1138.
74. Cramarossa, S. 1927 Vitality of some species in physiologiological salt solution and in twice distilled water. Pathologica, 19, 15-21.
75. Crawford, A.B., and Frank, A.H. 1940 Effect on animal health of feeding sewage. Civil Engineering, 10, 495.
76. Crone, P.B. 1951 Multiplication of certain Salmonella species in autoclaved buffered tap water. J. Path. Bact., 63, 167-168.
77. Cummins, S.L., Davies, D., and Acland, C.M. 1929 Living tubercle bacilli in septic tank effluent. Tubercle, 10, 310-314.
78. Curran, H.R. 1935 The influence of some environmental factors upon the thermal resistance of bacterial spores. J. Infectious Diseases, 56, 196-202.
79. Darling, C.A., and Siple, P.A. 1941 Bacteria of Antarctica. J. Bact., 42, 83-98.
80. Davies, R. 1939 Influence of normal blood and certain of its constituents on growth and viability of the tubercle bacillus. Tubercle (supp.), 20, 5-49.
81. De Assumpcao, L., and Leitee, S.H. 1943 Seasonal variations of typhoparatyphoid bacteriophages in waters of rivers of city of Sao Paulo. Arq. de Hig. e Saude Pub., Sao Paulo, 7, 101-108.

82. De Giaya, N.I. 1889 Ueber das Verhalten einiger pathogener Mikroorganismen im Meerwasser. Z. Hyg., 6, 162-224.
83. D'Herelle, F. 1926 The bacteriophage and its behaviour. Baillere, Tindall, and Cox, London.
84. D'Herelle, F., Malone, R.H., and Lahiri, M.N. 1930 Studies on Asiatic cholera. Indian Med. Research Mem., No. 14.
85. DoBell, C. 1919 The amoebae living in man. A Zoological Monograph, London.
86. DoBell, C., and Laidlaw, P.P. 1926 On the cultivation of Entamoebae histolytica and some other entozoic amoebae. Parasitol., 18, 283.
87. Dudgeon, L.S. 1914 The occurrence of living tubercle bacilli stored in normal saline. Lancet, 92, 210-213.
88. Dudgeon, L.S. 1919 Med. Research Council Spec. Rep., Series No. 40.
89. Duff, D.C., MacArthur, M.I., and Thompson, H. 1940 Observations on viability of Bacterium salmonicida. J. Fish. Research Bd., Canada, 5, 1-7.
90. Duhot, E., and Rachez, J. 1933 Comparative survival of bacilli (coli) introduced experimentally into distilled water and into various mineral waters. Compt. rend. soc. biol., 112, 1432-1434.
91. Eisman, P.C., Kull, F.C., and Mayer, R.L. 1949 The bacteriological aspects of deionized water. J. Am. Pharm. Assoc., 38, 88-91.
92. Ellison, G., Hackler, H.W., and Buice, W.A. 1928 Comparison of numbers of B. coli in iced and un-iced samples of water shipped to laboratory for bacteriological examination. South. Med. J., 21, 948-949.
93. Emmerich, N.I., and Pinto, N.I. 1889 Arch. Hyg., 9.
94. Evans, C.A., and Osterud, K.L. 1946 Failure of poliomyelitis virus to grow in certain protozoa of sewage. Science, 104, 51-53.
95. Faber, H.K., Kong, L., and Silverberg, R.J. 1951 A search for poliomyelitis virus in house dust and a study of drying on the viability of the virus. J. Infectious Diseases, 88, 180-186.
96. Falk, A. 1947 Water-borne tularemia. Minnesota Med., 30, 849-850.
97. Felsen, J. 1945 Dysentery, colitis, and enteritis. W.B. Saunders Co., Philadelphia.
98. Ficker, M. 1898 Ueber Lebensdauer und Absterben von pathogenen Keimen. Z. Hyg., 29, 1.
99. Firth, R.H. 1902 On the viability of the enteric bacillus in soil and sewage, and its bearing upon some methods of sewage disposal. J. San. Inst., London, 23, 614-619.
100. Flu, P.C. 1921 Experiments on the longevity of the Vibrio cholerae and Bacillus typhosus in septic tanks at Batavia. Med. Burgerlisken Geneeskundigen Dienst in Nederlansch Indie, No. 3, 289.
101. Ford, W.W., and Watson, E.M. 1912 On the seasonal variations in the bacterial flora of the Baltimore city water. Johns Hopkins Hosp. Bull., 23, 275-279.
102. Fraenkel, N.I. Ueber den Bacteriengehalt des Eises. Z. Hyg., (see Prudden 1887).

103. Francis, T., Jr., Brown, G., and Penner, L. 1948 Search for extrahuman sources of poliomyelitis virus. J. Am. Med. Assoc., 136, 1088-1092.
104. Frankland, E. 1895 On the conditions affecting bacterial life in Thames water. Proc. Roy. Soc. London, 57, 439-450.
105. Frankland, P.F. 1886 On the presence and vitality of pathogenic microorganisms in water. San. Rec., London, 8, 387-389.
106. Frankland, P.F. 1894 Microorganisms in water., Konradi 1904.
107. Frankland, P.F. 1894 Proc. Roy. Soc., 56.
108. Frankland, P.F. 1895 Ueber das Verhalten des Typhusbacillus und des Bacillus coli communis im Trinkwasser. Z. Hyg., 19, 393-407.
109. Frantsev, A.V. 1935 Stuffing boxes of pumps as source of B. coli in tap water. Grease as source of carbon for B. coli. Microbiologiia, 4, 655-659.
110. Freen, C.A., and MacLeov, M.C. 1943 Explosive epidemic of Sonne dysentery. Brit. Med. J., 2, 259.
111. Frost, W.D., and Whitman, R. 1905 The viability of B. dysenteriae Shiga. Science, 21, 483.
112. Gardner, A.D., and Wylie, J.A.H. 1946 Laboratory diagnosis of Weil's disease. Lancet, 250, 955-958.
113. Gaustad, V. 1947 Tuberculous primary infection in three children, occurring in connection with fall into highly contaminated river water. Acta Tuberc. Scandinav., 21, 281-291.
114. Gelarie, A.J. 1916 Vitality of cholera vibrio in water of New York Bay. Med. Rec., 89, 236-239.
115. Gershenfeld, L.D. 1947 Water ecology. Am. J. Pharm., 119, 283-291.
116. Gilcreas, F.W., and Roberts, H.V. 1950 Bacteriologic studies in disinfection of air in large rural central schools. I. Ultraviolet irradiation. Am. J. Pub. Health, 40, 808-812.
117. Gillissen, G. and Lust, D. 1950 Zur Differenzierung von Milzbrandbazillen und Milzbrandaehnlichen Sporenbildnern und die Bedeutung ihres Vorkommens in Abwaessern. Zentr. Bakt. 1 Abt. Orig., 156, 99-107.
118. Glass, G.B.J. 1948 An epidemic of tularemia by insects in settlements of deportation, Asino and Joya, Siberia, Soviet Russia. Am. J. Med. Sci., 216, 411-424.
119. Gloyne, S.R. 1928 Viability of tubercle bacillus under zero conditions outside the body. Tubercle, 9, 573.
120. Gohar, M.A., Elyan, A., Makkawi, M., Eissa, A., and Bashatly, A. 1948 Viability of pathogenic intestinal organisms in sea water with special reference to Vibrio cholerae. J. Roy. Egyptian Med. Assoc., 31, 358-372.
121. Gray, J.D.A. 1932 The significance of Bacterium aerogenes in water. J. Hyg., 32, 132.
122. Green, C.E., and Beard, P.J. 1938 Survival of Eberthella typhi in sewage treatment plant processes. Am. J. Pub. Health, 28, 762- 770.
123. Greer, F.E. 1926 Anaerobes in sewage. Am. J. Pub. Health, 16, 500-501.

124. Greer, F.E. 1928 The sanitary significance of lactose-fermenting bacteria not belonging to the B. coli group. Factors influencing the survival of microorganisms in water. J. Infectious Diseases, 42, 545-550.
125. Guelin, A. 1948 Etude quantitative du bacteriophage de la mer. Ann. Inst. Pasteur, 74, 104-112.
126. Gutfeld, F.V., and Pinulssen, L. 1928 Investigations on the action of light on bacteria. Centr. Bakt. Parasitenk, 1 Abt., 109, 107-115.
127. Haffkine, N.I., and Simpson, N.I. 1895 Ind. Med. Gaz., 30, 89.
128. Haines, R.B. 1937 The effect of freezing on bacteria. Proc. Roy. Soc., London, B 124, 451-463.
129. Hale, F.E., and Melia, T.W. 1910 Studies on inhibition, attenuation, and rejuvenation of B. coli. Am. J. Pub. Hyg., 20, 622-628.
130. Hampil, B. 1932 The influence of temperature on the life processes and death of bacteria. Quart. Rev. Biol., 7, 172-196.
131. Hankin, E. 1896 L'action bactericide des eaux de la Jumna et du Gange. Ann. Inst. Pasteur, 10, 511-523.
132. Hanlin, E. 1896 Les microbes des rivieres de l'Inde. Ann. Inst. Pasteur, 10, 175-176.
133. Hastings, E.G. 1923 Comparative resistance of bacteria from native habitats and from artificial cultures. J. Infectious Diseases, 33, 526-530.
134. Hecker, M. 1948 Uber den Nachweis von Bakterien der Typhus, Paratyphus, Enteritisgruppe im Abwasser mittels des Nahrbodens von Wilson und Blair. Z. Hyg. Infektionskrankh., 128, 388-392.
135. Hegner, R. 1934 Transmission of Endamoeba histolytica in drinking water. J. Parasitol., 20, 199.
136. Heller, G. 1941 Quantitative study of environmental factors involved in survival and death of bacteria in desiccated state. J. Bact., 41, 109-126.
137. Herdman, B. 1899 Thompson-Yates Laboratories Report No. 2.
138. Hess, N.I. 1934 Atlantic Fisheries Exp. Sta., J. Biol. Bd. Canada, 1, 95-108.
139. Hesse, W. 1889 Unsere Nahrungsmittel als Nährböden für Typhus und Cholera. Z. Hyg., 5, 527-546.
140. Hettche, H.O. 1937 Zur Ätiologie der Rotlaufinfektion. Arch. Hyg., 119, 178-183.
141. Heukelekian, H. 1933 Effect of dilution of sewage on bacterial numbers. Sewage Works J., 5, 774-787.
142. Hewlett, R.T. 1905 The duration of vitality of the typhoid bacillus in natural waters. J. State Med., London, 8, 165-167.
143. Hilliard, C.M., and Davis, M.A. 1918 The germicidal action of freezing temperatures by bacteria. J. Bact., 3, 423-431.
144. Hilliard, C.M., Torission, C., and Stone, R.P. 1915 Notes on the factors involved in the germicidal effect of freezing and low temperatures. Science, 42, 770-771.
145. Hinds, M.E. 1932 The factors which influence the longevity of B. coli and B. typhosus in water. Univ. Illinois Bull., No. 14, Water Survey Series, 13, 225.

146. Hitchens, A.P., and Ross, O.A. 1943 Bubbling drinking fountains. J. Am. Water Works Assoc., 35, 165-167.
147. Hochstetter, M. 1887 Ueber Mikroorganismen im künstlichen Selterwasser. Arb. kaiserl. Gesundh., 2, 1-38.
148. Hoffmann, E. 1926 On syphilitic infection with material from dead bodies and possible parasitic life of Spirochaeta pallida. Munch. Med. Wochnschr., 73, 185-187.
149. Holwerda, K. 1928 Experiments on changes in bacterial flora of stored polluted surface water, especially with view to Clemesha's method for ascertaining recency of pollution. Mededeel. V.D. Dienst D. Volksgezondh. in Nederl.-Indie, 17, 298-356.
150. Honkanen, A. 1947 Length of survival of tubercle bacilli in waste waters. Acta Soc. Med. Fenn. Duodecim (Ser. A. Fasc. 1), 24, 31-40.
151. Horrocks, W.H. 1903 J. Roy. Army Med. Corps, 1, 362.
152. Horrocks, W.H. 1911 On the viability and possible variation of the Bacillus typhosus. J. Roy. Army Med. Corps, London, 16, 225-250.
153. Hoskins, J.K. 1935 Bacterial purification rates in polluted water. U.S. Pub. Health Repts., 50, 385.
154. Houston, A.C. Laboratory tests of effect of storage on vitality of typhoid bacillus in London water supply. Eng. News, 60, 247.
155. Houston, A.C. 1908 The vitality of the typhoid bacillus in artificially infected samples of raw Thames, Lee, and New River waters, with special reference to the question of storage. First Report on Research Work, Metropolitan Water Board, London.
156. Houston, A.C. 1908 Vitality of the typhoid bacillus in raw river water. Pub. Health, London, 22, 30.
157. Houston, A.C. 1909 Third report on research work on the storage of raw river water antecedent to filtration. Metropolitan Water Board, London.
158. Houston, A.C. 1909 Metropolitan Water Board, 4th Research Rept.
159. Houston, A.C. 1910 Vitality of typhoid bacilli in artificially infected samples of river water. Met. Water Bd. 6th Research Report.
160. Houston, A.C. 1911 Seventh Report on Research Work. Met. Water Bd., London.
161. Houston, A.C. 1911 The comparative vitality of "uncultivated" and "uncultivated" typhoid bacilli in artificially infected samples of raw river water with special reference to the question of storage. Med. Officer, London, 5, 81-84.
162. Houston, A.C. 1912 Significance of B. coli in water. Brit. Med. J., No. 2699, 901.
163. Houston, A.C. 1913 Studies in Water Supply, London.
164. Houston, A.C. 1914 Tenth report on research work. Met. Water Bd., London.
165. Hutchings, R.H., and Wheeler, A.W. 1903 An epidemic of typhoid fever due to impure ice. Am. J. Med. Sci., 126, 680-684.

166. Hutchison, D., Weaver, R.H., and Scherago, M. 1943 The incidence and significance of microorganisms antagonistic to Escherichia in water. J. Bact., 45, 29.
167. Jacotot, H. 1926 Vitality of Pasteurella of hemorrhagic septicemia of animals. Compt. rend. soc. biol., 95, 1020-1021.
168. Jellison, W.L., Kohls, G.M., Butler, W.J., and Weaver, J.A. 1942 Epizootic tularemia in the beaver, Castor canadensis, and the contamination of stream water with Pasteurella tularensis. Am. J. Hyg., 36, 168-182.
169. Jellison, W.L., Epler, D.C., Kuhns, E., and Kohls, G.M. 1950 Tularemia in man from a domestic rural water supply. Pub. Health Repts., 65, 1219-1226.
170. Jepsen, A., and Christiansen, M.J. 1940 Orienterende undersögelser over forekomstem af Tuberkelbakterier i aflobsvand fla slagterier og mejerier. Beretn. 5 Nord, Vet. Möde, KbH 1939.
171. Jessen, N.I., and Rabinowitch, N.I. 1910 Z. Tuberc., 16, 275.
172. Jirovec, O., and Peter, R. 1948 Uber die Resistenz der Tridhomonaden gegen einige Umweltfaktoren. Schweiz. Z. Path. Bakt., 11, 146-166.
173. Johnson, F.H., and Harvey, E.N. 1938 Bacterial luminescence, respiration and viability in relation to osmotic pressure and specific salts of sea water. J. Cellular Comp. Physiol., 11, 213-232.
174. Jones, H.M.R. 1936 B. coli in the drinking water of ships: The effect of storage. J. Path. Bact., 42, 605-615.
175. Jones, M.F., and Newton, W.L. 1948 The survival of cysts of Endamoeba histolytica in water at temperatures between 45C and 55C. Am. J. Trop. Med., 30, 53-58.
176. Jordan, E.O. 1895 On some conditions affecting the behaviour of the typhoid bacillus in water. Med. News, 67, 337-343.
177. Jordan, E.O., Russell, H.L., and Zeit, F.R. 1904 The longevity of the typhoid bacillus in water. J. Infectious Diseases, 1, 641.
178. Kahn, S., and Agarwal, M.N. 1929 Duration of life of cholera vibrio in Ganges and Jumna River water. Indian J. Med. Research, 16, 993-1008.
179. Kahn, S. 1930 On the vibriocidal power of the water of certain rivers of India. Ind. J. Med. Res., 18, 361-365.
180. Karlinski, J. 1889 Ueber das Verhalten einiger pathogener Bakterien im Trinkwasser. Arch. Hyg., 9, 113.
181. Karlinski, J. 1907 Ueber Serotherapie der Ruhr. Wiener Klin. Wochnschr. 1906, 19, 1550.
182. Karpoff, S.P., and Antonoff, M.I. 1936 Spread of tularemia through water, as a new factor in its epidemiology. J. Bact., 32, 243-258.
183. Kehr, R.W., and Butterfield, C.T. 1943 Notes on the relation between coliforms and enteric pathogens. U.S. Pub. Health Repts., 58, 589-607.
184. Keith, S.C. 1913 Factors influencing the survival of bacteria at temperatures in the vicinity of the freezing point of water. Science, 37, 877.
185. Kennedy, N.I. 1905 Rep. Comm. Medit. Fev., Part 3.

186. Kiribazeuski, S., and Aida, T. 1934 U.S. Pub. Health Eng. Abst., 14, 61.
187. Kister, J. 1930 B.coli in water. Techn. Gemeindeblatt, 33, 219-221.
188. Klein, E. 1905 The vitality of the typhoid bacillus in shellfish. Tr. Path. Soc. London, 56, 230-238.
189. Kliger, I.J. 1921 Investigations of soil pollution and the relation of various types of privies to the spread of intestinal infections. Intern. Health Bd., Monograph, Rockefeller Inst. Med. Research, No. 15, 1-75.
190. Kling, C., Levaditi, C., and Lepine, P. 1929 Survival of the virus of acute anterior poliomyelitis in water and its passage through intestinal mucosa of monkey. Bull. acad. med., Paris, 102, 158-169.
191. Kling, C., Olin, G., Fahraeus, J., and Norlin, G. 1942 Acta Med. Scand., 112, 217-263.
192. Kling, C., Olin, G., Fahraeus, J., and Norlin, G. 1944 Sewer water as carrier and disseminator of poliomyelitis virus. Bull. Acad. Med., Paris, 126, 249-251.
193. Koch, R. 1886 New Sydenham Soc., 115, 370.
194. Konradi, D. 1904 Ueber die Lebensdauer pathogener Bakterien im Wasser. Centr. Bakt. 1 Abt. Orig., 36, 203-211.
195. Korinek, J. 1926 Uber Susswasserbakterien im Meere. Centr. Bakt. 2 Abt., 66, 500-505.
196. Koser, S.A., and Skinner, W.W. 1922 Viability of the colon-typhoid group in carbonated water and carbonated beverages. J. Bact., 7, 111-121.
197. Kraus, C. 1887 Ueber das Verhalten pathogener Bacterien im Trinkwasser. Arch. Hyg., 6, 234-252.
198. Krumbiegel, E.R. 1944 Transmission of virus diseases by water. Bull. Hyg., 19, 513.
199. Kruse, W. 1895 Ueber die Hygienische Bedeutung des Lichtes. Z. Hyg., 19, 313-333.
200. Kuenen, W., and Swellengrebel, N. 1913 Die Entamöben des Menschen umd ihre praktische Bedeutung. Centr. Bakt., 1 Abt. Orig., 71, 378-410.
201. Kusama, H. 1925 Viability of Bacillus dysenteriae. Philippine J. Sci., 27, 1-7.
202. Kyriasides, K. 1931 Experiments on the importance of protozoa in the self-purification of water. Gas-und Wasserfach., 74, 891.
203. Lahiri, M.N., Das, P.C., and Malik, K.S. 1939 The viability of Vibrio cholerae in natural waters. Indian Med. Gaz., 74, 742-744.
204. Landsteiner, K., Levaditi, C., and Pastia, M. 1911 Experimental studies of acute poliomyelitis. Ann. Inst. Pasteur, 25, 805.
205. Lang, H. 1947 Tularemia. M.S.C. Veterinarian, 7, 120-136.
206. Latarjet, R., and Morenne, P. 1951 Inactivation of a bacteriophage by ultraviolet rays of a very low intensity. Ann. Inst. Pasteur, Paris, 80, 220-224.
207. Laubach, L.A. 1916 Spore-bearing bacteria in water. J. Bact., 1, 505.

208. Leidy, N.I. 1884 Organisms in ice. Proc. Acad. Nat. Sci., Philadelphia.
209. Lendon, N.C., and Mackenzie, R.D. 1951 Tracing a typhoid carrier by sewage examination. Month. Bull. Med. Res. Counc. (Great Britain), 10, 23-27.
210. Lensen, S.G., Rhian, M., Stebbins, M.R., Bakus, R.C., and Peterson, C.E. 1949 Inactivation of partially purified poliomyelitis virus in water by chlorination. III. Experiments with natural waters. Am. J. Pub. Health, 39, 1120-1128.
211. Levine, M. 1921 Iowa Eng. Exp. Sta. Bull., 62, 66.
212. Levine, M. 1940 Bacteria from chlorinated water supplies. Rept. Proc. 3rd Intern. Congr. Microbiol., 1939, 733-735.
213. Levine, M. 1941 Determination and characterization of coliform bacteria from chlorinated waters. Am. J. Pub. Health, 31, 351-358.
214. Levine, M. 1947 Is incidence of the colon group an adequate sanitary index. Fourth Intern. Congr. Microbiol.
215. Levine, M., Carpenter, P., and Coblentz, J.M. 1939 Bacteria from chlorinated waters. J. Am. Water Works Assoc., 31, 1511-1523.
216. Lieb, F., and Fleischanderl, J. 1947 Ueber die Haltbarkeit von Typhus-und Paratyphus keimen in Mineralwassern. Wien. Klin. Wochnschr., 59, 153-154.
217. Lipman, C.B. 1926 Concentration of sea-water as affecting its bacterial population. J. Bact., 12, 311-313.
218. Livingston, G.S. 1921 Vitality and viability of hemolytic streptococci in water. Am. J. Hyg., 1, 239.
219. Lloyd, B. 1937 Bacteria in stored sea water. J. Roy. Tech. Coll., Glasgow, 4, 173-177.
220. Lochhead, A.G. 1938 Bacteria in dust-laden snow. Science, 87, 487.
221. Loebker, N.I., and Bruns, H. 1906 Uber das Wesen und die Verbreitung der Wurm Krankheit(Ankylostomiasis), mit besonderer Berücksichtigung ihres Auftretens in deutschen Bergwerken. Arb. Kais. Gesundh. Amt. Berlin, Bd., 23, 421-524.
222. Loesener, W. 1896 Uber das Verhalten von pathogenen Bakterien in beerdigten Kadavern und über die dem Erdreich und Grundwasser von solchen Gräbern angeblich dronenden Gefangen. Arb. Kais. Gesundh., 12, 448-539.
223. Lomry, P. 1929 Survival of typhoid bacteria outside of the body. Compt. rend. soc. biol., 101, 480-481.
224. Lomry, P. 1929 Survival of diphtheritic and typhoid-paratyphoid bacilli outside of the body. Compt. rend. soc. biol., 101, 482-483.
225. Lovell, R., Levi, M., and Francis, J. 1944 Studies on the survival of Johne's bacilli. J. Comp. Path. Therap., 54, 120-129.
226. Lu, T.H. 1933 Cold weather resistance of contagious bacilli of digestive organs. J. Oriental Med., 18, 865-874.
227. Luckiesh, M., and Holladay, L.L. 1942 Tests and data on disinfection of air with germicidal lamps. General Electric Rev., 45, 223-231.

228. Lund, A.J., and Halvorson, H.O. The effects of low temperature on enzymes and microorganisms. Hormel Inst., Publication No. 62.
229. Lu-Ti-Huan, N.I. 1930 Resistance of contagious bacilli of digestive organs against cold weather. J. Oriental Med., 13, 40.
230. Maccolini, R. 1946 Multiplication potency of various species of coli-aerogenes group in water. Boll. Soc. Ital. Biol. Sper., 22, 919-920.
231. MacConkey, A. 1905 Lactose-fermenting bacteria in faeces. J. Hyg., 5, 333.
232. McFarland, N.I. Text on Pathogenic Bacteria.
233. McFarlane, V.H. 1940 Behaviour of microorganisms at subfreezing temperatures. Distribution and survival of microorganisms in frozen cider, frozen syrup-packed raspberries, and frozen brine-packed peas. Food Research, 5, 43-57, 59-68.
234. McFarlane, V.H. 1941 Behaviour of microorganisms at subfreezing temperatures. III. Influence of sucrose and H-ion concentrations. Food Research, 6, 481-492.
235. McNaught, J.G. 1910 On the resistance of B. coli to sunlight and drying. Centr. Bakt., 1 Abt., 53, 326-334.
236. Mallmann, W.L. 1937 A bacteriological survey of a swimming pool treated with silver. Eng. Exp. Sta. Bull. Michigan. 12, Bull. No. 73.
237. Mallmann, W.L., and Churchill, E.S. Bacteriology in connection with base exchange water. Dept. Bact. Pub. Health, Michigan State College.
238. Marginesu, P. 1929 The influence of pH on the presence of bacteriophages in industrial water. Igiene Mod.
239. Matsuda, S. 1910 Kaigun Guni Kaiho, No. 31.
240. Maxcy, K.F. 1949 Supposed involvement of water supplies in poliomyelitis transmission. J. Am. Water Works Assoc., 41, 696-704.
241. Maxcy, K.F., and Howe, H.A. 1943 The significance of the finding of the virus of infantile paralysis in sewage. Sew. Works J., 15, 1101-1111.
242. Maximov, A.A. 1947 Basic types of tularemia vectors, their characteristics and geographical distribution in the RSFSR. Proc. Acad. Sci., U.S.S.R., 57, 501-503.
243. Mazurczak, L. 1945 Tracing the source of water contamination by a bacteriological method. Mitt. Lebensm. Hyg., 36, 393-397.
244. Mazzeo, M. 1940 Vitality of Escherichia coli in well waters rich in chloride. Boll. Soc. Ital. Biol. Sper., 15, 562-563.
245. Melnick, J.L. 1947 Poliomyelitis virus in urban sewage in epidemic and in nonepidemic times. Am. J. Hyg., 45, 240-253.
246. Messerschmidt, T., and Wedemeyer, R. 1951 Der Nachweis von Typhus-und Paratyphusbakterien in stadtischem Abwasser. Zentr. Bakt., 1 Abt. Orig., 156, 489-490.
247. Michael, I. 1886 Typhus-bacillen im Trinkwasser. Fortschr. Med., 4, 355-358.

248. Miller, D.H. 1939 The transmission of tularemis by the fin prick of a catfish. The Mil. Surgeon, 84, 23-29.
249. Minett, F.C. 1950 Sporulation and viability of B. anthracis in relation to environmental temperature and humidity. J. Comp. Path. Therap., 60, 161-176.
250. Ministry of Health 1934 The bacteriological examination of water supplies. Repts on Pub. Health and Medical Subjects, London, No. 71.
251. Moriya, G. 1909 Ueber die Umwandlungshypothese und Lebensdauer des Tuberkelbacillus. Centr. Bakt. 1 Abt. (Orig.), 51, 480-493.
252. Morris, N.I. 1921 Thirty-third Ann. Rep. Louisiana Agric. Exp. Sta.
253. Mouzet, H. 1936 Survival of various intestinal bacteria in water. Technique Sanitaire et Municipal, 31, 64-66.
254. Muir, N.I., and Ritchie, N.I. 1903 Manual of Bact., 324.
255. Musehold, P. 1900 Uber die Widerstandsfähigkeit der mit dem Lungen auswurf herausbeförderten Tuberkelbazillen in Abwassern, im Flusswasser und im Kultivirten Boden. Arb. Kaiserl. Gesundh., 17, 56-107.
256. Naik, R.N. 1938 Dissemination of anthrax infection through dirty stagnant pools. Indian J. Vet. Sci. and Animal Husbandry, 8, 243-245.
257. Newton, W.L., Bennett, H.J., and Figgat, W.D. 1949 Observations on the effects of various sewage treatment processes upon eggs of Taenia saginata. Am. J. Hyg., 49, 166-175.
258. Nicoll, W. 1917 Observations on the influence of salt and other agents in modifying the larval development of the hookworms: Ankylostoma duodenale and Necator americanus. Parasitol., Cambridge, 9, 157-189.
259. Noguchi, H. 1918 Survival of Leptospira icterohaemorrhagiae in nature; microchemical reactions and intermediary hosts. J. Exp. Med., 27, 609.
260. Nordgren, G., Funquist, P., and Andren, S.G. 1939 Orienterende Untersuchungen uber die Wirkung Smoglichkeiten des Chlors auf Bakterien in Wasser bei Gegenwart Verschiedener Organischer Substanzen. Acta Path. Microbiol. Scand., 16, 1-43.
261. Obst, M.M. 1919 The longevity of bacteria in bottled commercial spring water. J. Am. Pharm. Assoc., 8, 735-745.
262. Oker-Blom, M. The bactericidal action of ultraviolet light in clear, turbid, and colored water. Z. Hyg., 74, 197-241.
263. Osler, W. 1901 Practice of Medicine (4th Ed.).
264. Pandit, S.R., and Maitra, N.M. 1938 Vibrios in natural water sources in Assam. Indian J. Med. Research, 26, 39-40.
265. Panisset, L., Verge, J., and Carneiro, V. 1925 Action of saline and distilled water on microbes. Ann. Inst. Pasteur, 39, 80-85.
266. Panja, G., and Ghosh, S.K. 1947 Cholera vibrio: isolation from Hooghly River water at Calcutta. Indian J. Med. Research, 35, 1-2.

267. Park, W.H. 1901 Duration of life of typhoid bacillus in ice. Effect of intense cold on bacteria. Science, 13, 323.
268. Park, W.H. 1907 The importance of ice in the production of typhoid fever. J. Am. Med. Assoc., 49, 731.
269. Park, W.H. 1920 Public health and hygiene. Lea and Febiger, Philadelphia, Penna.
270. Parker, R.R., Jellison, W.L., Kohls, G., and Davis, G. 1940. Tularemia infection found in streams. U.S. Pub. Health Rep., 55, 227.
271. Parker, R.R., Steinhaus, E.A., and Kohls, G. 1943 Tularemia in beavers and muskrats and the contamination of Natural waters and mud by Pasteurella tularensis in the northwestern United States. J. Bact., 45, 56-57.
272. Penfold, W., Woodcock, H., and Drew, A. 1916 The excystation of Entamoeba histolytica as an indication of the vitality of the cysts. Brit. Med. J., 1, 714.
273. Pesch, K.L., and Sauerborn, E. 1929 Chemical and bacteriological sewage investigations. Gesundh. Ing., 52, 856.
274. Pfuhl, E. 1902 Vergleichende Untersuchungen über die Haltbarkeit der Ruhrbacillen und der Typhusbacillen auberhalt des menschlichen Körpers. Z. Hyg. Infektionskrankh., 40, 555-566.
275. Pieper, E., and Retzlaff, E. 1930 "Lebensdauer und Formerhaltung der Gonokokken in Flüssigkeiten". Zentr. Bakt., Abt. 1, 118, 47-50.
276. Platt, A.E. 1935 Viability of Bacterium coli and Bacterium aerogenes in water. A method for the rapid enumeration of these organisms. J. Hyg., 35, 437-438.
277. Pramer, D., Heukelekian, H., and Ragotzkie, R.A. 1950 Survival of tubercle bacilli in various sewage treatment processes. I. Development of a method for the quantitative recovery of mycobacteria from sewage. U.S. Pub. Health Repts., 65, 851-859.
278. Prescott, S.C., and Winslow, C.A. 1904 Elements of Water Bact.
279. Previtera, A. 1945 Sulla variazione dell'Escherichia coli nel terreno. Atti R. Accad. Fisiocrit. Siena, Sez. Med.-Fis., 13, 57, 118-123.
280. Prudden, T.M. 1887 On bacteria in ice, and their relations to disease, with special reference to the ice supply of New York City. Med. Record, 31, 341-350, 369-378.
281. Purdy, W.C., and Butterfield, C.T. 1918 Effect of plankton animals upon bacteria death rates. Am. J. Pub. Health, 8, 499.
282. Raghavachari, T.N.S., and Seetharama, I.P.V. 1939 Longevity of coliform organisms in water stored under natural conditions. Indian J. Med. Research, 26, 877-884.
283. Read, W.D.B., Singh, G., Seal, S.C., and Bose, S. 1939 Growth and survival of cholera vibrio, especially in water. Indian J. Med. Research, 27, 1-40.
284. Rector, F.L., and Daube, H.J. 1917 Longevity of Bacillus coli in water. Absts. Bact., 1, 57.

285. Remlingen, P., and Nouri, D. 1909 Les microbes pathogenes du sol peuvent-ils penetrer a l'interieur des vegetaux. Compt. rend. soc. Biol., 67, 646-647.
286. Renk, N.I. 1893 Ueber das Verhalten der Cholerabacillen im Eise. Fortschritte der Med., 10, 396.
287. Rhines, C. 1935 The longevity of tubercle bacilli in sewage and stream water. Am. Rev. Tuberc., 31, 493-497.
288. Rhodes, A.J., Clark, E.M., Knowles, D.S., Goodfellow, A.M., and Donohue, W.L. 1950 Prolonged survival of human poliomyelitis virus in experimentally infected river water. Canadian J. Pub. Health, 146-149.
289. Ridenour, G.M., Carlson, H.J., and McKhann, C.F., Jr. 1943 Effect of activated-sludge process on poliomyelitis virus. Sewage Works J., 15, 673-677.
290. Ritter, C., and Treece, E.L. 1948 Sanitary significance of cocci in swimming pools. Am. J. Pub. Health, 38, 1532-1538.
291. Rochaix, A. 1930 Recherches sur la persistance et la disparition des germes pathogenes dans l'eau d'egout. Ann. Hyg. Pub. Indust. Soc., 8, 669-675.
292. Rochaix, A. 1931 Investigation of the viability and death of pathogenic bacteria in sewage. Zentr. Ges. Hyg., 419-420.
293. Rochaix, A., and Urtinette, N.I. 1931 Antagonism of coli bacilli and putrid bacilli in water. Compt. rend. soc. biol., 106, 669-670.
294. Rogers, L.A. 1918 The occurrence of different types of the colon-aerogenes group in water. J. Bact., 3, 313-327.
295. Royds, N.I., and Jones, H.M.B. 1936 B. coli in the drinking water of ships: the effect of storage. J. Path. Bact., 42, 605-615.
296. Ruchhoft, C.C. 1934 Studies on the longevity of Eberthella typhi in sewage sludge. Sewage Works J., 6, 1054-1067.
297. Rudolfs, W.L., Falk, L., and Ragotzkie, R.A. 1950 Literature review on the occurrence and survival of enteric, pathogenic, and related organisms in soil, water, sewage, and sludges and on vegetation. II. Animal parasites. Sewage and Indust. Wastes, 22, 1417-1427.
298. Ruediger, G.F. 1911 Studies on the self-purification of streams. J. Am. Pub. Health Assoc., 1, 411.
299. Russell, H.L., and Fuller, C.A. 1906 The longevity of Bacillus typhosus in natural waters and in sewage. J. Infectious Diseases, Supp. No. 2, 40.
300. Ruys, H.C. 1897 Behaviour of typhoid bacillus in surface water. Bruxelles-med., 27, 708-714.
301. Ruys, A.C. 1941 On the behaviour of E. typhi in surface water. J. Microbiol. Serol., 7, 93-103.
302. Savage, W.G., and Wood, D.R. 1917 The vitality and viability of streptococci in water. J. Hyg., 16, 227-239.
303. Sawers, W.C. 1938 Some aspects of the Leptospirous problem in Australia. Med. J. Australia, 25, 1089-1097.
304. Sawyer, W.A., and Bauer, J.H. 1928 Survival of Spirochaeta icteroides in various environments. Am. J. Trop. Med., 8, 17-28.

305. Schmidt-Nielson, S. 1901 Beitrag zur Biologie der marinen Bakterien. Biol. Centr., 21, 65.
306. Schobel, O. 1914 The vitality of the cholera vibrio in Manila waters. Philippine J. Sci., Section B, 9, 479-480.
307. Schuller, A., and Erdmann, B. 1943 Beobachtungen bei einer Tularemie-epidemic. Z. Hyg. Infektionskrankh., 124, 624-635.
308. Schwarz, L., and Aumann, N.I. 1911 The action of ultraviolet rays on drinking water. Z. Hyg., 69, 1-16.
309. Scott, R.D., and McClure, G.M. 1924 The hydrogen-ion concentration of lime treated water and its effect on bacteria of the colon-typhoid group. J. Am. Water Works Assoc., 11, 578.
310. Shaughnessy, H.J., and Criswell, K.I. 1925 Studies on salt action. X. The influence of electrolytes upon the viability and electrophoretic migration of Bacterium coli. J. Gen. Physiol., 9, 123-136.
311. Shaughnessy, H.J. 1924 The effects of some electrolytes on the buffering capacity of Bacterium coli. J. Bact., 9, 559-579.
312. Shimomura, H.J. 1935 Experimental studies on the survival of B. typhosus in the sewerage water of Taihoka City (Formosa). J. Med. Assoc. Formosa, 34, 1294.
313. Sirena, N.I., and Scagliosi, N.I. 1894 Riforma Med., 2, 340.
314. Slater, C. 1893 A bacteriological investigation of artificial mineral waters. J. Path. Bact., 1, 468-488.
315. Smit, J. 1931 The process of self-purification in polluted waters. Wasser, 5, 178-192.
316. Steinhaus, E.A. 1943 Chlorine kills tularemia bacteria. Water Works and Severage, 90, 212.
317. Steinhaus, E.A., and Kohls, G.M. 1945 Tularemia in beavers and muskrats and the contamination of natural water and mud with Pasteurella tularensis in the northwestern United States. J. Bact., 45, 56-67.
318. Steuer, W. 1941 The viability of dysentery bacteria in well water. Arch. Hyg. Bakt., 126, 228.
319. Stewart, W. 1944 Viability of dysentery bacilli and transmission by flies in North Africa. J. Roy. Army Med. Corps, 83, 42-46.
320. Stewart, A.D., and Ghosal, S.C. 1932-1933 On the value of Wilson and Blair's bismuth sulphite medium in the isolation of B. typhosus from feces and sewage. Indian J. Med. Research, 20, 341-345.
321. Stokes, E.J., Jones, E.E., Monun, A.F., and Miles, A.A. Effect of drying and digestion of sewage sludge on pathogenic organisms. Inst. Sewage Purification, J. and Proc., 36-44.
322. Strauss, N.I., and Dubarry, N.I. 1889 Arch. de Med. Exp.
323. Stryszak, A. 1949 Behaviour of microorganisms of the Salmonella group in the sea-water of the Gulf of Gdansk. Bull. Inst. Marine and Trop. Med. (Gdansk), 2, 35-40, 213-219.

324. Stundl, K. 1941 Limnologische Untersuchungen an einigen wesffälischen Talsperren. Arch. Hydrobiol., 38, 70-97.
325. Symon, K. 1947 Jednoducha metoda k prukazu *Bact. prodigiosi* z vody a jeji prakticke pouziti. Spisy Lekarske Fak, Masarykovy Univ. (Brno), 21, 1-7.
326. Tanner, F.W. 1944 The microbiology of foods. Garrard Press, Champaign, Illinois, 2nd Ed.
327. Tanner, F.W., and Wallace, G.C. 1931 Effect of freezing on microorganisms in various menstrua. Proc. Soc. Exp. Biol. Med., 29, 32-34.
328. Tashiro, Y. 1932 Experimental investigation on sterilization of water in common bath for sailors; viability of bacilli (typhoid) in water of proper temperature for bathing. Bull. Nav. Med. Assoc. Japan, 21, 4-6.
329. Taylor, C.B. 1949 Factors affecting the bacterial population of lake waters. Proc. Soc. Appl. Bact., 1949, 4-10.
330. Taylor, C.B., and Collins, V.G. 1949 Development of bacteria in waters stored in glass containers. J. Gen. Microbiol., 3, 32-42.
331. Taylor, E. 1947 Bacteriology of water samples from water mains. Proc. Appl. Bact. (Great Britain), 1947, 34-38.
332. Teissier, J., and Couvreur, E. 1919 Longevity of *B. coli* in water. Compt. rend. soc. biol., 82, 257-358.
333. Thomas, S., and Kreidler, W.A. 1925 The effect of freezing on *Eberthella typhi*. Abs. Bact., 9, 25.
334. Thresh, J.C., and Richmond, A. 1909-1910 Notes on the *Bacillus coli* in deep well waters. Pub. Health, London, 23, 250-254.
335. Tinti, M. 1923 Der Einfluss der Temperaturerhöhungen auf die Oberflächenspannung bei werschiedenen Bacterienarten. Z. Immunitätsforsch. Exp. Therap. Jena., 36, 337-347.
336. Tohyama, Y. 1925 Experimental investigations concerning the prevention of epidemic diseases due to aquatic products. Sci. Repts. Gov't. Inst. Infectious Diseases, Tokyo, 4, 169-222.
337. Tohyama, Y. 1930 Experimental investigations concerning prevention of epidemic diseases due to aquatic products; resisting power of *Vibrio cholerae* against low temperature. Jap. J. Exp. Med., 8, 327-352.
338. Toomey, J.A., Takacs, W.S., and Weaver, H.M. 1945 Isolation of poliomyelitis virus from creek water by direct transmission to the cotton rat. Am. J. Diseases Children, 70, 293-297.
339. Topping, N.H. 1940 The preservation of the infectious agents of some of the rickettsioses. U.S. Pub. Health Repts., 55, 545-547.
340. Trask, J.D., and Paul, J.R. 1941 Observations on fecal examination in poliomyelitis. Am. J. Pub. Health, 31, 239-244.
341. Trask, J.D., and Paul, J.R. 1942 Periodic examination of sewage for the virus of poliomyelitis. J. Exp. Med., 75, 1-6.

342. Trawinski, A. 1929 Etudes sur la vitalite des bacilles pathogenes du groupe coli-typhique dans l'eau de mer. Bull. Inst. Oceanogr. (Monaco), 1929, 1-5.
343. Trevelyan, E.F. 1898 The behaviour of the diphtheria bacillus outside the human body. J. San. Inst. 1897, London, 18, 430-434.
344. Uffelman, J. 1889 Die Dauer der Lebensfähigkeit von Typhusund Cholerabacillen in Fäcalmassen. Centr. Bakt., 5, 497-502.
345. Vacek, B. 1932 Examination of some conditions necessary for the survival of the typhoid bacillus in water. Casopis Ceskoslov. Lekarnictva, 71, 97.
346. Vacek, B. 1933 Etude comparative sur quelques particularites biologiques du bacille typhique dans l'eau. Trav. Inst. Hyg. Publ. Etat Tchecoslovaque, 4, 39-72.
347. Veissfeiler, I., and Dvolaitskaya-Barischeva, K.M. 1935 The action of water and physiochemical factors on the tubercle bacillus. Beitr. Klin. Tuberk., 86, 151-159.
348. Velankar, N.K. 1950 Bacteriological survey of sea-water from the coast of Madras City (Bay of Bengal). Proc. Indian Acad. Sci., Sect. B, 32, 80-86.
349. Velz, C.J. 1949 Factors influencing self-purification and their relation to pollution abatement. Sewage Works J., 21, 309-319.
350. Vincent, J.H., and Muratet, L.M.P.A. 1917 Les dysenteries, les cholera Asiatique, le typhus exanthematique. Paris, Masson et Cie.
351. Violle, H., Raynaud, M., and Prudhomme, A. 1942 De la vitalite du bacille typhique et du B. coli dans l'eau de mer. Compt. rend. soc. biol., 136, 689-690.
352. Waksman, S.A., and Hotchkiss, M. 1937 Viability of bacteria in sea water. J. Bact., 33, 389-399.
353. Ward, W.E., and Dack, G.M. 1939 Bacteriologic tests on mechanical dishwashers for home use. Am. J. Pub. Health, 29, 1114-1118.
354. Watanabe, N. 1930 Term of existence of typhoid bacilli in hot-spring water and other waters. J. Pub. Health Assoc., Japan, 6, 1-10.
355. Webster, W.J. 1934 Ann. Rep. King Institute, Guindy, Govt. Press, Madras. (See Raghavachari 1939).
356. Wenyon, C.M., and O'Connor, F.W. 1917 Human intestinal protozoa in the Near East. London, Wellcome Bureau of Scientific Research.
357. Wheeler, J.M. 1906-1907 The viability of Bacillus typhosus under various conditions. J. Med. Research, 15, 269-299.
358. Wheeler, J.M. 1907 Some experiments on the typhoid bacillus in water and ice. Vermont Med. Month., 13, 110-116.
359. Whipple, G.C., and Mayer, A. 1906 On the relation between oxygen in water and the longevity of the typhoid bacillus. J. Infectious Diseases, Supp. No. 2, 8-72.
360. Whipple, M.C. 1922 Fifteen years of investigations by the laboratories of the Metropolitan Water Board. J. Am. Water Works Assoc., 9, 208-225.

361. Wibaut, N.L., and Moens, S. 1927 The disappearance of typhoid bacteria in water. Ver. D.A. deel. Naturk. Komm. Akab. V. Wetensch., 36, 1129.
362. Wilson, H. 1944 Some risks of transmission of disease during the treatment, disposal, and utilization of sewage, sewage effluent, and sewage sludge. Inst. Sewage Purification, J. and Proc., 234-238.
363. Wilson, W.J., and Blair, E.M. 1931 Further experience of the bismuth sulphite media in the isolation of Bacillus typhosus and B. paratyphosus B from feces, sewage and water. J. Hyg., 31, 138-161.
364. Wilson, W.J., and Dickson, C. 1911-1912 The viability of the B. typhosus in water and its isolation therefrom. J. Roy. San. Inst., London, 27, 472-477.
365. Winslow, C.E.A., and Brooke, O.R. 1927 The viability of various species of bacteria in aqueous suspensions. J. Bact., 13, 235-242.
366. Winslow, C.E.A., and Cohen, B. 1918 The distribution and relative viability of Bacillus coli and Bacillus aerogenes in water. Absts. Bact., 2, 4-5.
367. Winslow, C.E.A., and Cohen, B. 1918 The relative viability of B.coli and B. aerogenes types in water. J. Infectious Diseases, 23, 82-89.
368. Winslow, C.E.A., and Dolloff, A.F. 1928 Elative importance of additive and antagonistic effects of cations upon bacterial viability. J. Bact., 15, 67-92.
369. Winslow, C.E.A., and Falk, I.S. Studies on salt action. I. Effect of calcium and sodium salts upon the viability of the colon bacillus in water. Proc. Soc. Exp. Biol. Med., 15, 67.
370. Winslow, C.E.A., and Falk, I.S. 1919 The effect of mineral salts upon the viability of bacteria in water. Abstr. Bact., 3, 5.
371. Winslow, C.E.A., and Falk, I.S. 1923 Studies on salt action. VIII. The influence of calcium and sodium salts at various hydrogen-ion concentrations upon the viability of Bacterium coli. J. Bact., 8, 215-244.
372. Wolffhügel, G., and Riedel, O. 1886 Die Vermehrung der Bacterien im Wasser. Arb. Kaiserl. Gesundtatsamte, 1, 455-480.
373. Wolman, A. 1924 Hygienic aspects of sewage sludge as fertilizer. Eng. News-Record, 92, 198.
374. Wood, D.R. 1943 Growth of coliform bacteria in water. Analyst, 68, 147.
375. Wright, C.T. 1950 Pollution of irrigation waters. Sewage and Indust. Wastes, 22, 1403-1412.
376. Wright, W.H., Cram, E.B., and Nolan, M.O. 1942 Preliminary observations on the effect of sewage treatment processes on the ova and cysts of intestinal parasites. Sewage Works J., 14, 1274-1280.
377. Yasuhara, S. 1926 J. Pub. Health Assoc., Japan, 2, 1-3.
378. Yasukawa, Y. 1933 Experiments on sea water and Vibrio cholerae. Jap. J. Exp. Med., 11, 119-127.
379. Zeiss, H. 1926-1942 Tularemia epidemic in southeastern Russia. Seuchen-Atlas.

380. Zichis, J. 1948 Duration of viability of neurotropic viruses in an experimental plumbing system contaminated by back siphonage. Science, 108, 503-505.
381. ZoBell, C.E. 1934 Microbiological activities at low temperatures with particular reference to marine bacteria. Quart. Rev. Biol., 9, 460-466.
382. ZoBell, C.E. 1936 Bactericidal action of sea water. Proc. Soc. Exp. Biol. Med., 34, 113-116.
383. ZoBell, C.E. 1941 The occurrence of coliform bacteria in oceanic water. J. Bact., 42, 284.
384. ZoBell, C.E. 1942 Microorganisms in marine air. Aerobiology, No. 17, 55-68.
385. ZoBell, C.E. 1942 Bacteria of the marine world. Sci. Month., 55, 320-330.
386. ZoBell, C.E., Anderson, D.Q., and Smith, W.W. 1937 The bacteriostatic and bactericidal action of Great Salt Lake water. J. Bact., 33, 253-262.
387. ZoBell, C.E., and Conn, J.E. 1940 Studies on the thermal sensitivity of marine bacteria. J. Bact., 40, 223-238.
388. ZoBell, C.E., and Feltham, C.B. 1934 Preliminary studies on the distribution and characteristics of marine bacteria. Bull. Scripps Inst. Oceanogr., Tech. Ser., 3, 279-295.
389. ZoBell, C.E., and Johnson, F.H. 1949 The influence of hydrostatic pressure on the growth and viability of terrestrial and marine bacteria. J. Bact., 57, 179-189.
390. ZoBell, C.E., and McEwen, G.F. 1935 Lethal action of sunlight upon bacteria in sea water. Biol. Bull., 68, 93-106.
391. ZoBell, C.E., and ZoBell, M.H. 1932 Metabolism studies of abortus and melitensis group; viability in aqueous solutions. J. Infectious Diseases, 50, 538-541.

The following authors appear in the references(water) but no data appears in the tables:

11.	Arthur, D.	1894-95
20.	Basset, J	1932
42.	Brown, L,	1916
57.	Castell, C.H.	1942
77.	Cummins, S.L.	1929
78.	Curran, H.R.	1935
104.	Frankland, E.	1895
115.	Gershenfeld, L.D.	1947
127.	Haffkine, N.I.	1895
144.	Hilliard, C.M.	1915
152.	Horrocks, W.H.	1911
166.	Hutchison, D.	1943
169.	Jellison, W.L.	1950
183.	Kehr, R.W.	1943
196.	Koser, S.A.	1922
207.	Laubach, L.A.	1916
212.	Levine, M.	1940
213.	Levine, M.	1941
217.	Lipman, C.B.	1926
227.	Luckiesh, M.	1942
231.	MacConkey, A.	1905
247.	Michael, I.	1886
262.	Oker-Blom, M.	
268.	Park, W.H.	1907
279.	Previtera, A.	1945
285.	Remlingen, P.	1909
303.	Sawers, W.C.	1938
340.	Trask, J.D.	1941
343.	Trevelyan, E.F.	1898
349.	Velz, C.J.	1949
368.	Winslow, C.E.A.	1928
369.	Winslow, C.E.A.	
370.	Winslow, C.E.A.	1919

SUMMARY OF ABBREVIATIONS USED IN TABLES

alk.	alkaline
avg.	average
C.	Degrees centigrade
Col.	Colonies
conc.	concentration
cont'd, cont.	continued
ct.	count
cult.	culture
d., ds., das.	day or days
Dessic.	Desiccate
dil.	dilution
F.	Degrees fahrenheit
fl.	fluid
G.P.	Guinea pig
gel.	Gelatin
h., hrs.	hour or hours
inc.	increase
Inoc., Innoc.	Inoculate
irrad.	irradiated
Lg.	Large
max.	maximum
med.	medium
met.	methyl
min.	minute or minutes
mos.	months
mult.	multiplied
org.	organism
path.	pathogenic
physiol.	physiological
ppm.	parts per million
ppt.	precipitate
R.H.	Relative humidity
R.T.	Room temperature
Recov.	Recovered
refrig.	refrigeration
sec.	second
sensit.	sensitization
soln., sol'n	solution
spp.	species
str.	strain
susp., susp'n	suspension
T.B., tb	tuberculosis
temp.	temperature
U.V., U.v., UV	Ultra violet
wks.	weeks
X	times
yr., yrs.	year or years
>	greater than
<	less than
+	present; plus
0	none
-	minus